PUBLIC DOCUMENT . . . . No. 4.

FORTY-FOURTH

ANNUAL REPORT OF THE SECRETARY

OF THE

MASSACHUSETTS

State Board of Agriculture,

TOGETHER WITH THE

NINTH ANNUAL REPORT OF THE HATCH EXPERIMENT STATION OF THE MASSACHUSETTS AGRICULTURAL COLLEGE.

1896.

BOSTON :
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 Post Office Square.
1897.

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State Board of Agriculture, 1897.

Members ex Officio.

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His Honor W. M. CRANE.
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	Term expires
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Hampshire, Franklin and Hampden,	EDWARD E. WOOD of Northampton,	1900
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Housatonic,	CHARLES B. BENEDICT of Egremont,	1900
Man'f'rs' Agr'l (N. Attleborough),	OSCAR S. THAYER of Attleborough,	1900
Marshfield (Agr'l and Hort'l),	WALTON HALL of Marshfield,	1900
Martha's Vineyard,	H. G. NORTON of West Tisbury,	1898
Massachusetts Horticultural,	E. W. WOOD of West Newton,	1900
Massachusetts Society for Promoting Agriculture,	FRANCIS SHAW of Wayland,	1900
Middlesex North,	A. C. VARNUM of Lowell,	1898
Middlesex South,	ISAAC DAMON of Wayland (P. O. Cochituate),	1899
Nantucket,	J. S. APPLETON, Jr., of Nantucket,	1900
Oxford,	W. M. WELLINGTON of Oxford,	1898
Plymouth County,	AUGUSTUS PRATT of North Middleborough,	1899
Spencer (Far's and Mech's Assoc'n),	JOHN G. AVERY of Spencer,	1898
Union (Agr'l and Hort'l),	CURTIS M. BLAIR of Blandford,	1898
Weymouth (Agr'l and Ind'l),	QUINCY L. REED of South Weymouth,	1900
Worcester,	J. LEWIS ELLSWORTH of Worcester,	1899
Worcester East,	W. A. KILBOURN of South Lancaster,	1900
Worcester North,	GEORGE CRUICKSHANKS of Fitchburg,	1899
Worcester North-west (Agr'l and Mech'l),	T. H. GOODSPEED of Athol (P. O. Athol Centre),	1898
Worcester South,	G. L. CLEMENCE of Southbridge,	1898
Worcester County West,	E. A. HARWOOD of North Brookfield,	1899

THE FORTY-FOURTH ANNUAL REPORT

OF THE

SECRETARY

OF THE

BOARD OF AGRICULTURE.

To the Senate and House of Representatives of the Commonwealth of Massachusetts.

The year 1896 was not one of marked prosperity to the farmers of Massachusetts, although the crops were generally good and the season in the main favorable. Prices were low and the markets were overloaded. A large majority of 112 crop correspondents reporting in November stated that prices had ruled lower than for several years. The season showed the diversities of weather. April was favorable for farm work and the season opened earlier than usual. May brought a drought that checked the growth of early crops, shortened the feed in pastures and injured the prospect for the hay crop. Fall seedings did not winter well and the drought delayed recovery from the damage thus received. The apple bloom was unprecedented, and small fruits also blossomed full. Other fruits did not promise well. There were no peach blossoms. Canker worms were unusually plenty in some sections, but other insects were not more than usually prevalent during the spring months. Good help was reported slightly more plenty than usual, and wages were in some cases reported to be a little lower than last year, the average being $16 to $20 per month with board and $1.25 to $1.50 per day without board.

June gave good weather for the season. About as much corn as usual had been planted, but it was somewhat back-

ward, owing to the unfavorable weather of May. There was an increase in acreage of fodder and ensilage corn. A less acreage of potatoes was reported, the big crop and very low prices last year having had the usual discouraging effect. Early market-garden crops yielded well, but prices were low. Late crops were reported in good condition. Prices for dairy products were lower in June than in former years, while the supply was above the average, on account of fine condition of the pastures. Prospect for apples and small fruits was good, while the promise for pears and cherries was light. Cut worms were unusually prevalent and did considerable damage to tobacco in the Connecticut valley.

July was favorable for most crops, but did not furnish the usual amount of good hay weather. The hay crop was short, on account of lack of moisture in the early part of the season, and was considerably damaged in making. Rye, oats and barley were good crops, and Indian corn was growing fast and had nearly recovered from the effect of unfavorable weather of May. A feature of July was the appearance of the army worm in destructive numbers generally throughout the State.

August was favorable for corn, forage crops, rowen, fall feed and pastures. Tobacco was harvested in fine condition and was a splendid crop, but prices for this crop are still low. An extra crop of Indian corn was harvested in September. Fall seeding made a good catch. Onions did not yield an average crop and autumn prices were low; later prices were higher, and growers that held the crop were fortunate. Late potatoes were injured by drought early in the season and later by blight and grubs. The crop was below the average in quantity and quality, while prices were less than last year, but competition of localities where the crop was larger and of finer quality prevented a boom. The promise of a large apple crop was more than realized, and probably the largest crop of winter apples ever grown in the State was harvested. The foreign and domestic markets were glutted by the over-supply, and prices were unremunerative. Our orchardists are somewhat discouraged by these conditions. They feel that when prices are fair, the crop is small; when the crop is large, prices are too low for

profit. We must, however, admit that when we have a bountiful crop much of the fruit is undersized by reason of over-bearing, that insects injure a large proportion, that usually less care is used in packing, that the greater part of the crop is thrown upon the market as soon as it is harvested. The natural result is an over-supply of ordinary fruit, and low prices. Our State is in the natural apple belt, and can produce as fine fruit as can be grown in any section. The market will always take a reasonable amount of the finest fruit at fair prices. We must take better care of our trees, fertilize our orchards, destroy the insects by spraying, thin the fruit severely, that size and good color may be attained. Exercise the utmost care in picking, sorting and packing, and hold a large part of every bountiful crop in cold storage until the market will absorb it. Simple and inexpensive cold-storage houses can be provided within the means of most fruit growers, and the fruit can be kept in fine condition with little waste even until late in spring. In this connection reference is made to pages 232 and 339 of this volume.

The cranberry crop was not as remunerative as usual, partly because of the low prices and partly because of the abundance of the apple crop. No doubt the stagnation in business and the "hard times" have been a large factor in causing the low prices that rule not only for farm crops but for manufactured articles as well.

Sixty-one of the 120 correspondents making returns November 1 considered hay to have been among the most profitable crops; 28, corn; 14, potatoes; 9, milk; 9, cabbages; 6, tobacco; 6, sweet corn; 5, strawberries; 5, cranberries; 4, asparagus; 4, apples; 3, oats; 3, tomatoes, etc. Fifty-five correspondents gave potatoes as among the least profitable crops; 36, apples; 11, corn; 4, squashes; 4, onions; 3, turnips; 3, cranberries, etc.

Massachusetts Weather, 1896.

[Compiled from data furnished by the New England Weather Service.]

January opened cold, and an unusually sharp cold wave prevailed from the 4th to the 8th. Peach buds were almost entirely killed and some damage was done to raspberries and

blackberries. The rest of the month was milder. The ground was not protected by snow during the cold spell, but there was a slight covering during the rest of the month.

February was a rough, stormy month, with damaging floods, heavy snows and much rainy and cloudy weather. The heaviest rain and snow fall came on the 4th to 7th and the 29th to March 3d. A severe cold wave prevailed on the 17th and 18th. On the night of the 6th–7th hurricane signals were hoisted in Boston for the first time in the history of the Weather Bureau, and the wind reached a velocity of over 60 miles an hour.

March was typical of the month, though rougher and more stormy than usual. The rainfall was above the normal and the number of stormy days also in excess. The snowfall was more than usual and there was a fair snow covering till near the end of the month. The changes in temperature were rapid, but the daily ranges were not great.

The first and last parts of April were comparatively cool, with frequent frosts, but the middle of the month gave almost unprecedented heat for the season. The rainfall was deficient, and at the end of the month grass and grain were feeling the effects of dry weather. The cool weather of the first and last of the month held the fruit buds in check, with good results.

Unusually fair, warm and dry weather prevailed over the greater part of Massachusetts during the month of May. There were light frosts in eastern districts on the 20th, 21st and 24th, but no damage was done. Only a trace of rain fell during the first two-thirds of the month, and much grass land suffered severely. Insect pests were reported as very plentiful. The frosts were not severe enough to damage fruit buds to any extent. Apples blossomed from a week to ten days earlier than the average.

The month of June gave nearly normal weather conditions over the greater part of the State. Many of the nights were too cool for the best growth of corn, but no damaging frosts occurred. High temperatures prevailed, but there was no excessive heat. Moderate showers were well distributed, and there was a general soaking rain on the 14th. At the end of the month, however, the top of the soil was getting

dry. There were practically no damaging winds or local storms to injure the fruit.

Along the coast the mean temperature for July was below the normal and the temperature range was small. The rainfall was below the normal along the coast, but was in excess in the interior. There was a good deal of foggy and cloudy weather and the number of rainy days was more than usual. The high wind on the 16th did some damage to corn, grain and fruit in western counties. The month was a poor one for harvesting, but a splendid one for the growth of all field crops.

August opened with plenty of heat, sunshine and moisture. Unusually hot and sultry weather continued over the second week of the month, and most crops made a very rapid growth. The last half of the month was somewhat cooler and drier, with plenty of sunshine. There was a marked absence of severe local storms and no continuous rains. Streams and wells got very low and the subsoil was very dry. The month was warmer and drier than the normal.

Light frosts occurred during September on several dates in valleys and on level plains, but there was no general killing frost. Rain was frequent and excessive in all districts, and the ground was well filled with water at the end of the month. At Boston the mean daily temperature was very near the normal. The weather was exceptionally favorable for the growth of late forage crops, and grass on old fields also thickened up. Local rain and thunder storms were frequent and damaging.

October gave an unusual amount of cloudy, stormy weather, although in eastern districts the total rainfall for the month was fully an inch below the normal amount. A number of severe storms passed near enough to give cloudy, threatening weather and some wind, but not near enough for us to get the worst part of the disturbance. The most noteworthy was the West India hurricane of the 12th to 16th. This was first noted over the West Indies on the 7th, and moved slowly up the coast well out to sea. Warning signals were ordered and displayed all along our coast, giving ample warnings of the gale. The wind reached hurricane force on our extreme eastern coast, while the centre of the

storm was several hundred miles outside. At Boston the mean temperature for the month averaged one and one-third degrees a day lower than the normal. The highest temperature was 76° on the 31st and the lowest 33° on the 26th. Killing frosts were noted over most of our district on the 19th or 20th, but, as most of the crops were already gathered, but little if any damage was done. The wet weather was favorable for pastures and for fall-sown grain and grass seed. The ground was well filled with water, and wells and reservoirs were generally full and ready for winter weather.

November was very mild and pleasant. The average daily excess in temperature was from 3.5° at Nantucket to 6.2° at Cambridge. At many places in the State it was the warmest November on record. The chief warm spells of the month were on the 16th to 19th and the 27th to 28th. On one of those dates the temperature rose to 70° or over at most places. Excessive humidity prevailed during the warm spells. Between the two warm periods a sharp fall of temperature occurred, which was in marked contrast to them. The mercury fell to from 10° to 20° below freezing throughout the district. Snow fell on the 14th and on the night of the 29th–30th, and a thin covering of snow lay on the ground at the end of the month. The precipitation was slightly deficient for the month, but there was an abundant fall for the needs of the soil, and all crops entered the winter in good shape. The weather was favorable for all out-door work during the month, and was generally improved.

December was deficient in both temperature and precipitation, although there was a mild period of considerable length in the first half of the month. A cold period prevailed from the 15th to the 28th, while the last three days gave warmer, thawing weather. On the southern coast the precipitation was very near the normal fall, but in other sections there was a marked deficiency. In the western part of the State the snowfall was moderate, but on the southeastern coast and on the islands south of the coast the fall was heavier than usual. At New Bedford the total snowfall was 24 inches and at Taunton it was 21 inches. The greater part of this snow came in the storms of the 16th and 23d. On the Cape these storms approached the severity of a bliz-

zard, and interrupted travel and telegraphic communication. During the storm of the 16th the wind reached a velocity of 80 miles an hour for five minutes at Block Island, R. I., and a single gust blew at the rate of 110 miles. At Nantucket a velocity of 62 miles an hour was recorded. There was considerable snow on the ground at the end of the month, especially in southern and eastern districts. A very brilliant display of aurora was visible throughout the State on the evening of the 3d.

Meteorological Observatory of the Hatch Experiment Station (Massachusetts Agricultural College), Amherst.

[Latitude, 42° 23′ 48.5″ N.; longitude, 72° 31′ 10″ W. Height of instruments above ground, 51 feet; above sea level, 273.5 feet.*]

Annual Summary for 1896.

Pressure (in Inches).

Maximum reduced to freezing, 30.60, Dec. 27, 12 P.M.
Minimum reduced to freezing, 28.42, Feb. 6, 11.30 P.M.
Maximum reduced to freezing and sea level, 30.94, Dec. 27, 12 P.M.
Minimum reduced to freezing and sea level, 28.72, Feb. 6, 11 30 P.M.
Mean reduced to freezing and sea level.†
Annual range, 2.22.

Air Temperature (in Degrees F.).‡

Highest, 97, Aug. 12.
Lowest, —14, Feb. 17.
Mean.*
Mean of means of max. and min., 47.0.
Mean sensible (wet bulb), 44.
Annual range, 111.
Highest mean daily, 81, May 10.
Lowest mean daily, —1.7, Feb. 17.
Mean maximum, 57.3.
Mean minimum, 36.6.
Mean daily range, 20.7.
Greatest daily range, 47, April 16.
Least daily range, 3, Oct. 5.

Humidity.

Mean dew point, 39.9.
Mean force of vapor, .422.
Mean relative humidity, 76.9.

Wind, Prevailing Directions (Per Cent).

North, 10.
South, 10.
South-south-west, 10.
West, 10.
South-west, 7.
Other directions, 53.
Total movement, 59,198 miles.
Greatest daily movement, 620 m., March 4.
Least daily movement, 14 m., Feb. 1.
Mean daily movement, 161.7 miles.
Mean hourly velocity, 6.7 miles.
Maximum pressure per square foot, 25 pounds = 71 miles per hour on May 18, at 8 A.M.

Precipitation (in Inches).

Total precipitation, rain or melted snow, 39.66.
Number of days on which .01 inch or more rain or melted snow fell, 108.
Snow total in inches, 44.

Weather.

Mean cloudiness observed, 49 per cent.
Total cloudiness recorded by sun thermometer, 2,018 hours = 46 per cent.
Number of clear days, 132.
Number of fair days, 102.
Number of cloudy days, 132.

Bright Sunshine.

Number of hours recorded, 2,448 hours = 54 per cent.

Dates of Frosts.

Last, May 1; May 20 in lowlands.
First, Sept. 24; Sept. 21 in lowlands.

Dates of Snow.

Last, April 7.
First, Nov. 14.
Total days of sleighing, 31.

Gales of 50 Miles per Hour.

Jan. 1, 55 m., W. N. W.; Jan. 4, 52 m., N. W.; Feb. 2, 50 m., W. N. W.; Feb. 6, 61 m., N. E.; Feb. 7, 58 m., W. N. W.; Feb. 11, 68 m., W. N. W.; Feb. 14, 54 m., W.; Feb. 19, 70 m., W. S. W.; Feb. 24, 53 m., W.; Feb. 29, 57 m., E. S. E.; March 3, 61 m., N. N. W.; March 4, 62 m., N. N. W.; March 5, 58 m., N.; March 8, 56 m., W. N. W.; March 9, 56 m., N. W.; March 12, 59 m., W.; March 20, 55 m., W. N. W.; March 27, 52 m., W. N. W.; April 3, 60 m., N. W.; May 18, 71 m., W.; Aug. 26, 50 m., S. S. W.; Sept. 19, 57 m., S. W.; Nov. 6, 55 m., W.

LEONARD METCALF, *Meteorologist.*
JAMES L. BARTLETT, *Observer.*

* Record divided, part ground shelter, part tower shelter.
† See later bulletin.
‡ Temperature in ground shelter.

Massachusetts Crop Reports.

The publication of monthly crop bulletins was continued as in previous seasons, and six in all were issued (May–October), aggregating 232 pages of printed matter. Twenty-three hundred copies of No. 2 and 2,500 copies of Nos. 1, 3, 4, 5 and 6 were printed and distributed.

The special subjects treated were: Bulletin No. 1, "Report of meetings of Massachusetts Fruit Growers' Association;" Bulletin No. 2, "The grass crop;" Bulletin No. 3, "The army worm;" Bulletin No. 4, "The crow in Massachusetts;" Bulletin No. 5, "The Babcock milk tester;" and Bulletin No. 6, "Concentrated feed stuffs." These special articles will be found printed on pages 249–348 of this volume. Also, as in the past four years, this office co-operated with the New England Weather Service in the issuing of weekly weather-crop bulletins. The first was of date of April 28 and the last of date of September 29, in all representing an aggregate issue of 57,500 copies.

Publications.

The following publications were issued under the supervision of this office during the calendar year 1896: —

	Pages.	Number.	Date of Issue.
Agriculture of Massachusetts, 1895,	784*	15,000	April 11.
Catalogue of Abandoned or Partially Abandoned Farms, fifth edition, Supplement, ...	166	1,000	April 9.
Crop Bulletin, No. 1, May, . .	40	2,500	June 5.
Crop Bulletin, No. 2, June, . .	39	2,300	July 7.
Crop Bulletin, No. 3, July, . .	37	2,500	August 5.
Crop Bulletin, No. 4, August, . .	40	2,500	September 10.
Crop Bulletin, No. 5, September, .	36	2,500	October 6.
Crop Bulletin, No. 6, October, . .	40	2,500	November 7.
Regulations of Board, speakers and subjects, farmers' institutes, . .	10	500	November 4.

* Including eighth annual report of the Hatch Experiment Station, 190 pages.

In addition to the above publications, there were published under the direction of the Board of Agriculture in May 5,000 copies of an illustrated report of 607 pages of the work of destroying the gypsy moth in the Commonwealth of Massachusetts, together with an account of its history and habits both in Massachusetts and Europe. This report was prepared by Edward H. Forbush, field director in charge of the work, and Charles H. Fernald, A.M., Ph.D., entomologist to the Board.

There were also published by the Dairy Bureau of the Board 1,000 pamphlet copies of the laws of Massachusetts relating to dairy products and their imitations, with a digest of supreme court decisions thereon. This pamphlet was prepared by Mr. Geo. M. Whitaker, acting executive officer of the Bureau, and was issued in August.

Legislation.

The legislation of the year 1896 that had reference to the Board of Agriculture or to the agricultural societies was: "An act making appropriations for sundry agricultural expenses" (Acts of 1896, chapter 25); "An act relative to the tenure of office of members of the State Board of Agriculture" (Acts of 1896, chapter 254); "An act to incorporate the Manufacturers' Agricultural Society in North Attleborough" (Acts of 1896, chapter 260); a "Resolve to provide for the collection and circulation of information relating to abandoned farms" (Resolves of 1896, chapter 31); a "Resolve in favor of the Manufacturers' Agricultural Society in North Attleborough" (Resolves of 1896, chapter 85); a "Resolve to provide for carrying on the work of the suppression of the gypsy moth" (Resolves of 1896, chapter 100); also "Resolutions relative to the extermination of the gypsy moth."

Appropriations.

Objects for which appropriated	1894. Appropriated.	1894. Used.	1895. Appropriated	1895. Used.	1896. Appropriated.	1896. Used.	1897. Appropriated.
Bounties to societies,	$21,000 00	$20,629 80	$21,000 00	$20,606 20	$21,000 00	$20,084 12	$21,000 00
Travelling and necessary expenses of the Board,	1,900 00	1,787 85	1,900 00	1,509 93	1,900 00	1,600 03	1,900 00
Travelling and necessary expenses of the Secretary.	500 00	490 46	500 00	481 40	500 00	492 42	500 00
Incidentals in office of secretary,	700 00	700 00	700 00	700 00	800 00	800 00	800 00
Salaries of secretary and clerks,	5,300 00	5,300 00	5,300 00	5,300 00	5,300 00	5,300 00	5,300 00
Dissemination of useful information in agriculture by means of lectures or otherwise,	2,650 00	2,650 00	2,650 00	2,650 00	2,800 00	2,800 00	2,800 00
Printing 15,000 copies of the "Agriculture of Massachusetts,"	5,965 67	5,965 67	5,836 33	5,836 33	5,473 86	5,473 86	*5,200 00
Collecting and circulating information relative to abandoned farms,	†719 22	644 23	–	–	1,000 00	283 00	†727 00
Carrying forward work of Dairy Bureau,	4,000 00	4,000 00	7,000 00	6,477 68	7,000 00	6,998 95	7,000 00
Salary of executive officer of Dairy Bureau,	500 00	500 00	500 00	500 00	500 00	500 00	500 00
Salary of assistant in work of Dairy Bureau,	1,200 00	1,200 00	1,200 00	1,200 00	1,200 00	1,200 00	1,200 00
Nails or spikes for marking shade trees for preservation,	200 00	198 72	200 00	199 34	200 00	133 34	200 00
Printing 5,000 copies synoptical and analytical index to the "Agriculture of Massachusetts,"	‡393 36	393 36	–	–	–	–	–
Aggregates,	$45,028 25	$44,460 09	$46,786 33	$45,460 88	$47,673 86	$45,665 72	$47,127 00

* Estimated. † Unexpended balance. ‡ Deficiency.

Also $100,000 was appropriated to be used in the extermination of the gypsy moth. An appropriation of $200,000 for this work has been asked of the Legislature of 1897.

Nails for marking Trees.

The appropriation for this object was the usual $200, and there were expended during the year the following sums: —

266 pounds M spikes, $2\frac{3}{4}$ and $2\frac{1}{4}$ inches, . .	$15 96
1,152 pounds galvanized washers, . . .	116 88
Cartage, ...	50
	$133 34

Spikes and washers were supplied during the year to the towns of Athol, Hubbardston, Littleton, Milton, Phillipston and Winchendon. Since the work of supplying these spikes was begun, Dec. 26, 1891, 3 cities and 53 towns have availed themselves of the provisions of the act. In all there have been furnished 7,151 three and one-fourth inch spikes, 66,135 two and three-fourths inch spikes, and 55,533 two and one-fourth inch spikes, making a total of 128,819.

Abandoned Farms.

The granting by the Legislature of 1896 of an appropriation of $1,000 having made possible the doing of more work along this line, plans were duly made for a new edition of the catalogue of descriptions; and it was decided to issue a circular letter to the assessors of each city and town, similar to the letter used in 1891. It was further decided to ask for the assessors' valuation of each farm reported by them, and also to send a special circular to the assessors, asking for information concerning farms advertised in the catalogue and reported as "sold." In order to send a copy of the descriptive catalogue with the above-mentioned circular letters, it was found necessary to have more printed. Accordingly, in April 1,000 copies of a supplement to the fifth edition were printed. Seventeen new descriptions were added as an addenda, making the total of descriptions printed 560.

The effort to secure new descriptions resulted in the receipt of 61, which were incorporated in the new catalogue

(sixth edition), making the total number of descriptions printed 621. Also, as in past years, a circular of inquiry was mailed each owner and agent having a description in the catalogue of an undisposed-of farm.

Up to December 15 returns were received concerning, all told, 510 of the 560 farms described in the several previous editions of the catalogue. Of these, 242 were reports of "sales," 95 reports of "withdrawals" and 173 wished to have description continued. Nothing having been ascertained concerning 50 farms advertised in previous editions, these descriptions, as was intimated in the above-mentioned circular would be the case, were discontinued.

A large majority of the purchasers of these farms are of American parentage. The returns indicate the following: American, 151; Irish, 14; German, 8; French, 7; Scotch, 4; Danish, 3; English, 2; Swedish, 2; Italian, 1; Russian, 1; Prince Edward Island, 1; Nova Scotia, 1; undetermined, 47.

In regard to residence of purchasers at time of purchase the following is shown: Massachusetts, 144; New York, 11; Connecticut, 10; New Hampshire, 5; Rhode Island, 3; Florida, Ohio and Vermont, 2 each; Nova Scotia, Maine, Indiana, Illinois, Wisconsin and New Jersey, 1 each; unknown, 57.

In regard to the use which the purchasers intended to make of the farms purchased the returns show the following: For general farming, 93; for a home, 23; for an investment, 13; for a summer residence, 12; for poultry and farming, 7; for dairying, 7; for the wood and lumber, 6; for poultry culture, 5; for sheep raising, 3; for cranberry growing, fruit and poultry, poultry and market gardening and to cut into small lots for emigrants, 1 each. No statement was received concerning 69 of the farms reported sold.

The total acreage of the 242 farms reported sold is 26,693, or an average acreage of 110.30+. Two hundred and forty * of these farms sold for a total of $362,675, or an average of $1,511.14+.

The following gives a clearer idea of the acreage and price of the farms advertised in the several editions of the cata-

* Price not given for two farms.

logue and reported sold, and shows that nearly two-thirds of the farms ranged in acreage from 50 to 200 acres and that more than one-half ranged in price from $1,000 to $3,000 : —

Under 5 acres, 6 ; 5–20 acres, 15 ; 20–50 acres, 36 ; 50–100 acres, 70 ; 100–200 acres, 79 ; 200–500 acres, 34 ; 500 acres and over, 2.

Price under $300, 2 ; $300–$500, 15 ; $500–$1,000, 72 ; $1,000–$2,000, 91 ; $2,000–$3,000, 33 ; $3,000–$5,000, 23 ; $5,000 and over, 4.

The following table shows the work of this office to Jan. 1, 1897, the work having been begun in the spring of 1891 : —

COUNTIES.	Abandoned or Partially Abandoned Farms reported	Owners or Agents making Reply.	Not replying to Request for Description.	Not caring to dispose of Property.	Informant misinformed.	Returned by P. O. Dept. unclaimed.	Farms reported already disposed of.	Descriptions of Farms received.	Descriptions withdrawn by Request.	Descriptions withdrawn, parties not replying.	Farms reported Sold.
Berkshire, ...	333	169	164	17	4	26	7	141	12	12	48
Franklin, ...	229	95	134	12	8	10	6	69	10	5	28
Hampshire, ...	173	75	98	17	3	7	3	52	8	2	19
Hampden, ...	241	111	130	22	2	5	4	83	9	13	31
Worcester, ...	497	268	229	52	22	23	22	172	35	13	65
Middlesex, ...	81	39	42	8	1	9	3	27	5	1	9
Essex, ...	19	8	11	2	2	2	–	4	–	–	1
Suffolk, ...	–	–	–	–	–	–	–	–	–	–	–
Norfolk, ...	46	28	18	6	4	5	3	15	4	1	8
Bristol, ...	108	38	70	16	3	8	3	16	4	–	7
Plymouth, ...	99	42	57	6	1	2	6	29	5	–	18
Barnstable, ...	54	18	36	1	2	2	2	13	2	3	6
Dukes, ...	23	9	14	2	1	1	–	6	1	–	1
Nantucket, ...	15	6	9	3	–	–	–	3	–	–	1
Totals, ...	1,918	906	1,012	164	53	100	59	*630	95	50	242

* Nine descriptions not printed in the catalogue.

The cost of this work is shown by the following statement: —

Appropriation under chapter 280, Acts of 1891, .	$2,000 00	
Amount unused and reverting back to State treasury at the end of two years, Dec. 31, 1892, .	858 50	
	$1,141 50	
Appropriation under chapter 46, Resolves of 1893,	1,000 00	
	$2,141 50	
Amount unused and reverting back to State treasury at the end of two years, Dec. 31, 1894, .	74 99	
	$2,066 51	
Appropriation under chapter 31, Resolves of 1896,	1,000 00	
		$3,066 51
Printing 11,500 catalogues, 5 editions, 1 supplement, ...	$1,401 10	
Special envelopes, ...	154 32	
Postage stamps, ...	505 00	
Printed circulars, ...	87 29	
Advertising, ...	3 50	
Express, ...	2 00	
Special services, members of Board, . . .	196 30	
		2,349 51
Balance on hand Dec. 31, 1896, ...		$717 00

Scales of Points.

Scales of points or score cards have been supplied when called for, and the following is a record of the year's transactions in this line: —

Printing 1,000 cards, "grade dairy cows," . .	$5 25
Printing 1,000 cards, "Jerseys,"	5 25
Total, ...	$10 50

Cards in varying quantities were supplied on request the past year to six of the societies represented on the Board of Agriculture, to four other agricultural organizations in the States of Maine and Massachusetts, and to individuals in the States of Arkansas, Connecticut, Massachusetts and New Hampshire. The receipts for cards sold amounted to $23. Quite a quantity of the cards still remain in the office of the secretary.

FARMERS' INSTITUTES.

The 36 societies represented on the Board of Agriculture held 128 farmers' institutes during the calendar year 1896. Lecturers were furnished by this office for 96, 25 of these lecturers being members of the Board, at a total cost of $1,294.67 for services and expenses, an average of $13.48 per institute. All of the societies but the Massachusetts Society for Promoting Agriculture, which holds no institutes, held the required 3, and 13 held 4 or more. Lecturers report an increased interest in these institute meetings, which is shown by increased attendance and a general desire to secure the very best talent attainable. In November, 1896, a pamphlet was issued, for the use of officers of societies and institute committees, containing the regulations of the Board of Agriculture concerning the holding of farmers' institutes, with a list of available lecturers and their subjects. It is believed that the issuing of this pamphlet has been productive of much good.

GYPSY MOTH (*Ocneria dispar*).

The Legislature of 1896 appropriated $100,000 for the continuation of the work of exterminating this pest. The annual report of the committee of the Board in charge will be found printed on pages 349–433 of this volume. A special report on this insect, prepared by Messrs. Forbush and Fernald, has already been referred to under "Publications." At the annual meeting of the Board, Jan. 13, 1897, no changes were made in the committee in charge of the work of extermination, so that the committee for 1897 remains unchanged.

DAIRY BUREAU.

There has been no change in the personnel of the Dairy Bureau during the past year. The sixth annual report of the Bureau to the Legislature will be found printed on pages 435–454 of this volume.

Agricultural College.

The report of the examining committee of the Agricultural College will be found printed on pages 215–223 of this volume. The ninth annual report of the Hatch Experiment Station of the college (Pub. Doc., No. 31) is by law bound with the report of the secretary of the Board of Agriculture in this volume.

Returns of Societies.

These returns will be found printed on pages 457–486 of this volume. A summary, contrasting the totals of 1894, 1895 and 1896, is printed on page 486. Attention is called to the report of the committee on agricultural societies, which is printed on pages 224–225 of this volume.

Agricultural Directory.

A directory of the agricultural organizations of the Commonwealth, with officers for 1897, will be found printed on pages 487–501 of this volume. As it is a somewhat difficult task to make this directory complete and up to date, it would be considered a favor if those who are interested in this feature of the annual report of the secretary of the Board would report to the secretary any cases of omission or error which may come to their notice. The intention is to publish yearly an agricultural directory which can be relied upon as being accurate.

The Library.

The valuable reference library in the office of the secretary is being constantly enlarged, and its various branches made more complete by exchange, by gift and by purchase. Under a by-law of the Board the first clerk of the secretary has been appointed librarian and curator, and the general charge of the library has become a part of his duties. It is expected that when the Board removes to its new quarters in the State House the library will be thoroughly overhauled, and steps taken towards putting it in such condition, by indexing and cataloguing, that it will become even more valu-

able as a reference library than is possible at the present time.

Meetings of the Board.

The public winter meeting of the Board for lectures and discussions was held at Greenfield, Dec. 1, 2 and 3, 1896. The lectures and discussions will be found printed on pages 13–202 of this volume. A special business meeting of the Board was held at Greenfield, Dec. 1, 1896, an account of which will be found printed on pages 9, 10. The annual business meeting of the Board was held at the office of the secretary Jan. 12 and 13, 1897, and the minutes thereof, etc., will be found printed on pages 205–246 of this volume.

Changes in the Board.

During the past year death removed from the Board His Excellency Frederic T. Greenhalge, president *ex officio;* also Mr. A. D. Raymond of Royalston, who had represented the Worcester North-west Agricultural Society on the Board since February, 1895.

The following gentlemen retired from the Board at the recent annual meeting because of the expiration of their terms of service: Henry A. Cook of the Blackstone Valley Agricultural Society, after six years of service; W. M. Tucker of the Eastern Hampden Agricultural Society, F. E. Clark of the Hampden Agricultural Society, C. B. Lyman of the Hampshire, Franklin and Hampden Agricultural Society, Wm. H. Gove of the Hoosac Valley Agricultural Society, F. A. Palmer of the Housatonic Agricultural Society and John H. Bourne of the Marshfield Agricultural and Horticultural Society, — each after three years of service.

Cattle Commission.

The report of the Board of Cattle Commissioners (Pub. Doc., No. 51) is by law printed in the annual report of the State Board of Agriculture, and the report for 1896 will be found printed on pages 519–592 of this volume.

Farmers' National Congress.

The report of the delegates to the Farmers' National Congress at Indianapolis, Ind., Nov. 10–12, 1896, is by request included in this volume, and will be found printed on pages 505–517.

WM. R. SESSIONS,
Secretary of the State Board of Agriculture.

Boston, February, 1897.

MEETINGS OF THE EXECUTIVE COMMITTEE

OF THE

BOARD OF AGRICULTURE,

1896.

Meetings of the Executive Committee,

acting for the board.

Boston, Jan. 10, 1896.

The meeting was called to consider the question of petitioning the Legislature for legislation regulating the sale of commercial feed stuffs, the matter having been referred to the committee by the Board at the business meeting held at Dalton, Dec. 3, 1895.

Voted, That the secretary be instructed to consult with the master and the legislative agent of the State Grange, with members of the Board and with other prominent farmers, and endeavor to ascertain whether there is a considerable sentiment among the farmers of the State in favor of the enactment of a law regulating the sale of commercial feed stuffs and report at a later meeting of the committee.

Voted, That the secretary be instructed to correspond with the secretaries of the boards of agriculture of the other New England States and New York, and ascertain whether they are in favor of such legislation in their States, and whether measures have been undertaken or are in contemplation to obtain such legislation in their States.

Voted, That Mr. F. W. Sargent be excused, at his own request, from the duty of presenting a paper at the annual meeting, and that no substitute be engaged.

Boston, Jan. 17, 1896.

The committee met to hear the opinions of the master of the State Grange and others concerning the matter of petitioning the Legislature for the enactment of a law regulating the sale of commercial feed stuffs.

Voted, To lay the matter on the table.

BOSTON, March 21, 1896.

The meeting was called in part to consider the request of the Spencer Farmers' and Mechanics' Association for the approval by the Board of Agriculture of the unanimous vote of the said association to sell its Lincoln Street property. There was presented a copy of the call for the meeting at the town hall, Spencer, Feb. 24, 1896; also an attested copy of the records of that meeting, at which it was voted to instruct the executive committee to sell the Lincoln Street property, with the consent of the finance committee and approval by the State Board of Agriculture, and deeds be executed by the treasurer.

There was presented also a copy of the "Spencer Leader" and a copy of the "Spencer Sun," containing notice of the meeting of February 24; also a copy of the "Spencer Leader," containing the required advertisement of the hearing, one of the insertions of the notice having been at least one week before the date of hearing.

No person appearing in opposition to the vote of the association, it was

Voted, To approve the vote of the Spencer Farmers' and Mechanics' Association, passed on Feb. 24, 1896, "to instruct the executive committee to sell the Lincoln Street property, with the consent of the finance committee, and deeds be executed by the treasurer."

A request having been received from the Worcester Agricultural Society that it might change the dates assigned by the Board for the holding of its 1896 fair, in order that its dates might conform to those selected by the Bay State Agricultural Society, it was

Voted, That the Worcester Agricultural Society be allowed to change the dates for its 1896 fair to conform to the dates selected for the fair of the Bay State Agricultural Society, *i.e.*, to September 1, 2, 3 and 4.

A scale of points applicable for use in judging grade stock at fairs, prepared by Dr. G. M. Twitchell, was brought to the attention of the committee and was discussed.

Voted, That the Board of Agriculture adopt and publish a scale of points for grade cows.

Voted, That the scale of points suggested by Dr. Twitchell for judging grade cows, as amended by the executive committee, be adopted by the Board of Agriculture for the use of societies at their annual exhibitions.

Boston, Aug. 14, 1896.

The executive committee this day authorized the secretary to grant the Manufacturers' Agricultural Society of North Attleborough September 29 and 30 and October 1 as the dates for holding its fair in the year 1896.

SPECIAL MEETING

OF THE

BOARD OF AGRICULTURE,

AT

GREENFIELD.

December 1, 1896.

SPECIAL MEETING
OF THE
BOARD OF AGRICULTURE, AT GREENFIELD.

GREENFIELD, MASS., Dec. 1, 1896.

The Board of Agriculture met at the town hall, Greenfield, this day, at 9.30 A.M., for business.

Present: First Vice-Pres. James S. Grinnell, who presided, and Messrs. F. H. Appleton, J. S. Appleton, Jr., Avery, Blair, Bourne, Brewster, Bursley, Clemence, Cruickshanks, Damon, Ellsworth, Gove, Harwood, Hersey, Horton, Kilbourn, Lyman, Palmer, Pratt, S. M. Raymond, Reed, Sargent, Sessions, N. W. Shaw, Smith, Stetson, Taylor, Wellington and Wood.

The secretary called the attention of the Board to chapter 254 of the Acts of 1896, which provides that "the terms of the appointed members of said Board whose terms would expire on the first Wednesday of February in the year eighteen hundred and ninety-seven shall expire on the second Wednesday of January in said year." The law not providing when the annual meeting of the Board shall be, the secretary proposed that chapter IV. of the by-laws of the Board, which states when the annual meeting of the Board shall be held, be so amended that the annual meeting of the Board, instead of beginning on the Tuesday preceding the first Wednesday of February, should begin on the Tuesday preceding the second Wednesday of January, and thus conform to the time of the expiration of the terms of the members, as designated in the above-mentioned chapter.

Voted, That chapter IV. of the by-laws be so amended that the annual business meeting of the Board shall here-

after begin on the Tuesday preceding the second Wednesday of January.

The secretary read communications regarding the American Association of Institute Managers, also the constitution of the same, and stated that he had been requested to join the association, but that he did not think he ought to join, as he was not a director or manager of farmers' institutes; and further stated that he thought he ought to bring the matter to the attention of the Board.

On motion of Mr. F. H. Appleton, it was

Voted, That the matter of taking membership in the American Association of Institute Managers be referred to the executive committee, with full power to act.

The question of legislation to regulate the sale of commercial feed stuffs was brought to the attention of the Board by the secretary, and was discussed by the chairman, the secretary and Messrs. F. H. Appleton, Gove, Hersey, Sargent, N. W. Shaw, Stetson and Taylor.

Voted, That Dr. J. B. Lindsey of the experiment station be requested to prepare a bill for the regulation of the sale of commercial feed stuffs, and report the same to the Board at the annual meeting for consideration, and that the secretary be instructed to represent the Board in any consultation with organized dealers that may be arranged previous to the annual meeting.

The secretary presented and read the report of the gypsy moth committee to the Legislature. The report was discussed by Professor Fernald, entomologist to the Board and to the committee, the secretary and Messrs. F. H. Appleton, Avery, Blair, Hersey and Wood.

On motion of Mr. N. W. Shaw,—

Voted, That the report of the committee on the gypsy moth, to be presented to the Legislature, be approved by this Board.

The vote was unanimous, there being no negative votes.

Adjourned at 12 o'clock M.

PUBLIC WINTER MEETING

OF THE

BOARD OF AGRICULTURE,

AT

GREENFIELD.

December 1, 2 and 3, 1896.

Public Winter Meeting of the Board,

at Greenfield.

The annual public winter meeting of the Board was held in the town hall, Greenfield, beginning Tuesday, December 1, and continuing through the two following days. The weather was cool, with clear skies, and there was an unusually large attendance at the meetings.

The first session was called to order by Hon. James S. Grinnell, the first vice-president. Prayer was offered by the Rev. P. V. Finch of St. James' Church, Greenfield. The chairman then announced that the presiding officer for the remainder of the day would be Mr. A. A. Smith, president of the Franklin County Agricultural Society, and that he would deliver the address of welcome.

ADDRESS OF WELCOME.

BY MR. A. A. SMITH OF COLRAIN.

Mr. Chairman, members of the Board of Agriculture of Massachusetts and friends: The invitation of the Franklin County Agricultural Society to hold your public winter meeting of 1896 in this place having been accepted by your honorable Board, it becomes my pleasant duty and privilege to welcome you to this "the garden of the Commonwealth." First let me assure you that you are not assembled within the walls of a large city, but instead the beautiful and thriving village of Greenfield, which is fed and nourished by the fertile agricultural districts that surround it; the shire town of the county, whose people are interested in all that pertains to her welfare and prosperity. The Franklin County Agricultural Society expected that your honorable Board would accept its most cordial invitation when made, not that it needs your presence to strengthen and encourage more than other societies, not that it can entertain you better, but that from a meeting held in the midst of practical, intelligent, successful farmers, who will take part in the dis-

cussions and give their views upon different subjects, will disseminate through your valuable reports and the press, that knowledge of agricultural subjects which is not only theoretical but practical. I predict for you an earnest, intelligent and appreciative audience, and assure you that a cordial welcome is in the hearts of the people of Franklin County.

The county of Franklin, while one of the smallest in area in the State, does her full share in its agricultural productions. Seventeen years ago to-morrow you opened with imposing ceremonies your seventeenth annual winter meeting in this building. That meeting of the Board was productive of immense value to the agriculture of the State, and particularly to the Connecticut valley. It was considered by all to have been the most interesting meeting held to that date, and many still regard it as the commencement of a new era in the agriculture of Massachusetts. The butter exhibit in connection with that meeting gave a new impetus to the dairying branch of farming. Hon. James S. Grinnell, who was then president of the Franklin County Agricultural Society, chairman of the committee of arrangements and the moving spirit which guided the meeting to a most successful termination, welcomed your honorable Board to the hearts and homes of the people of Greenfield. In that address he gave to the public a very complete and exhaustive statement of the agricultural productions of the county up to and including the census of 1875.

I have thought that it would be of interest to you to know at this time whether the farmers of Franklin County have been true to their calling and public benefactors, in that they have made "two blades of grass grow where but one grew before" during the interim from 1875 until the present. I have been unable to procure the statistics from the State census of 1895, and am obliged to rely upon the national census of 1890; and I believe that the increase and decrease in the several productions will retain the same ratio during the five years not accounted for.

In 1875, according to the State census, the population of the county of Franklin was 33,696. The State census of 1885 showed an increase to the number of 37,449, while the

United States census of 1890 gave an increase to the number of 38,610. The United States census of 1890, as compared with the State census of 1885, shows that of the twenty-six towns comprising the county, the following named sustained a small loss in population, and it is a significant fact that many of them are not solely agricultural towns, so called: Ashfield, Bernardston, Buckland, Conway, Deerfield, Hawley, Heath, Leverett, Leyden, Rowe, Shelburne, Shutesbury, Sunderland, Warwick, Wendell and Whately.

At your last meeting held in this place there were reported to be 3,956 farms in the county, with an average acreage of 88; while according to the United States census of 1890 there were 3,011 farms, with an average acreage of 111; and of these 3,011 farms 2,823 were cultivated by the owners, 100 rented for a fixed money value and 88 for a share of products; thus showing that nearly 94 per cent of the farms of this county are owned and tilled by the same person; and from these farms, containing 185,611 acres of improved land, these same persons of indomitable will and perseverance produced in value of farm products in 1889 the sum of $1,996,600, and the value of live stock on hand June 1, 1890, was $1,182,630. Of the domestic animals in the county permit me to compare from the State census of 1875 and the United States census of 1890: neat cattle, — 1875, 21,902; 1890, 26,381; horses, — 1875, 4,098; 1890, 5,474; sheep, — 1875, 11,318; 1890, 12,361; swine, — 1875, 3,441; 1890, 8,202. Of the whole number of cattle reported, viz., 26,381, 14,213 were milch cows, 1,270 working oxen, including steers, and 10,898 all others.

The quality of the cattle of this county I can say without fear of contradiction surpasses that of any other section of the same area on this continent. The annual fairs of the Franklin County Agricultural Society testify to the truth of the above statement.

This increase in the number of cattle is largely due to the increased demand for dairy products, produced in the county with the most improved methods of manufacturing. There are in the county seven creameries in successful operation, working under the co-operative plan, collecting the cream from dairies, leaving the skim-milk, which is indispensable

in the successful raising of nice calves and pigs. In addition to the creameries there are very many private dairies, using the improved separators, having a ready market for all the butter they can produce. And still another class of consumers, by no means small in numbers, who demand the butter made in the good old way, believing that there is a something in the touch of the dairy-maid's hands in working the butter which gives it just the flavor desired.

The manufacture of cheese in the county is fast becoming one of the "lost arts," there being but one exhibit at either of the agricultural fairs in the county the present year. The exhibitor was Mrs. George W. Patterson of Colrain, who still persists in making large quantities of cheese of fine quality every year, to the delight of her epicurean customers.

The fine oxen, which were once the pride of nearly every farmer in the county, have quietly glided away and been supplanted by horses for general farm work and driving purposes, causing the large increase in numbers within the the county, as indicated in the table above quoted.

The decrease in the number of horses in the county will commence, if it has not already, when electricity is used to a large extent for travelling and freighting to and from market.

It is a pleasure also to note that during the period from 1875 to 1890 the number of sheep in the county increased from 11,318 to 12,361, notwithstanding there were killed by dogs, during the year 1889, 539, which is about the average yearly ration for the dogs of Franklin County. There were, according to the census returns of 1890, 9,177 lambs dropped in 1889, and of this number 5,222 were fattened and sold as spring lambs for consumption. It is with some degree of pride that the farmers of "little Franklin" peruse the increase of sheep husbandry as compared with other counties in the Commonwealth. The county of Berkshire possessed in 1890 14,158 sheep; lambs dropped, 9,777; Franklin County, in 1890, 12,361 sheep; lambs dropped, 9,177. Pounds of wool shorn in Berkshire, 65,171; pounds of wool shorn in Franklin, 67,876. I make these comparisons with our great and only competitor, to show

what can be done in sheep husbandry by good management and care. Berkshire, with 1,797 more sheep than Franklin, had only 600 more lambs; but with 1,797 less sheep Franklin produced 2,705 pounds more of wool. The proportion of fine and medium wools in the two counties was about the same, thus proving that care and management have much to do with success in this branch of farming.

The increase in production of the staple crops is in proportion to the large increase in domestic animals: —

Crops.

	1875.	1890.
Oats, bushels,	39,145	44,291
Indian corn, bushels,	154,310	183,241
Hay, tons,	61,056	76,784
Wool, pounds,	42,680	67,876
Tobacco, pounds,	1,997,091	915,296

Fruit product, value $130,722; in 1890, it is safe to estimate at 100 per cent increase. Value of the dairy products in 1875 was $424,042, while the value of milk produced upon the farms of Franklin County in 1889, based upon the price of ten cents per gallon, was $652,896.60.

We might pursue these comparisons, did time permit, yet I think enough has been stated to show your honorable Board that the farmers of Franklin County have been true to their calling, aided by the experiment station, in connection with the Agricultural College, both of which are some of the fruits gathered by the farmers of the Commonwealth through the exertions of your Board.

What is true of the agricultural interests in the county is also true of every other interest which tends to a higher civilization. Our schools, both public and private, are second to none in the State; and so long as the memory of Mary Lyon, Horace Mann, Dwight L. Moody and many others is cherished by the people, the best possible means will be offered to all for a most liberal education.

Our public thoroughfares are being greatly improved, through the generous yet wise legislation of the State in building many miles of macadam road within our borders. For these and like blessings the people "thank God and ask for more."

Electricity in the form of the telephone and as a motive power in travelling and moving freight is fast connecting the rural towns with the large centres of business. And so the march of progress moves on. What the future will develop it would be simply rashness to predict. The bicycle has come to stay, and the athletic sports, such as base ball, foot ball, tennis and golf, will be admired and patronized so long as our great institutions of learning foster and encourage them.

I trust that at your next annual winter meeting held in this county the one to whom is assigned the pleasant duty of giving you a welcome will be able to show far greater advancement in all that pertains to the progress of our people.

Gentlemen of the Board and friends, I have detained you perhaps too long, yet I must trespass upon your time to the extent of recording the high position which Franklin County has taken through its representative men in the organization and maintenance of the State Board of Agriculture of Massachusetts. As early as the year 1850 Hon. Amasa Walker, secretary of the Commonwealth, suggested in his report that a Board of Agriculture may be established by the authority of the State, corresponding in its general features to the Board of Education. In the year 1851 "The Voluntary Massachusetts Board of Agriculture" organized with Hon. Henry W. Cushman of Bernardston as first vice-president: and at a subsequent meeting of this volunteer board, held Jan. 14, 1852, the following was unanimously passed: —

Resolved, That, inasmuch as agriculture is the chief occupation of her citizens, the Commonwealth, in the organization of its government, should be provided with a department of agriculture, with offices commensurate with the importance of the duties to be discharged, of the abilities to be required, and of the labors to be performed.

The Legislature of that year almost unanimously passed a law creating the State Board of Agriculture, and it was signed by His Excellency Gov. Geo. S. Boutwell, who still lives to see the results of that wise legislation. The Hon. Henry W. Cushman did much to bring about the desired

legislation, and, as lieutenant-governor of the Commonwealth, was *ex officio* member of the Board. I am also proud of the fact that my father, Rominor Smith, Esq., represented the town of Colrain in the Legislature of Massachusetts that year, and exerted his influence in creating by law the State Board of Agriculture.

Nearly a half century has passed since its organization, and during that long period with but a short interim your chairman, the Hon. James S. Grinnell, has been an active member, whose wise counsel and earnest and zealous work has done much to make your Board so efficient and of national importance; and, Mr. Chairman, to you personally I extend, in behalf of the people of Franklin County, your associate members, aye, all the citizens of the Commonwealth, their gratitude for your devotion to the interests of agriculture within her borders. The names of other distinguished men who have served this society and State faithfully as members of the Board from Franklin County are Henry W. Clapp, Thomas J. Field, E. W. Stebbins, John M. Smith, I. K. Brown, T. L. Allis, W. L. Warner, John S. Anderson, John Buddington, Zeri Smith and J. C. Newhall, while the Deerfield Valley Society has given to the Board of her best talent in sending such men as Hon. Roger H. Leavitt, E. C. Hawks, Otis J. Davenport, F. G. Howes, J. D. Avery and Chas. E. Ward, all of whom, could they address you on this occasion, would bid you a hearty welcome and God-speed in your noble work.

Franklin County also gave one of her favorite sons, Hon. John E. Russell, as secretary of the Board, whose executive ability, aided by his extensive travels and love for the profession of agriculture, which he was able and willing to defend at any and all times, commanded the admiration of the whole people. You are welcome here, as in all other places in the State where you meet, because your work is a "labor of love." Your only recompense is the good you are doing to those whom you represent.

The farmers of Massachusetts "fired the first shot heard round the world," and assisted largely in framing the Constitution of the State, under which we live and prosper at the present time, always ready to defend the honor and

integrity of our great nation and beloved Commonwealth with their life's blood. They toil from early morn till dewy eve, realizing full well with the framers of this great nation that upon their success depends the prosperity of our republic. Occasionally a complaint comes from their lips of what seems to them an unjust proportion of the burdens of the government in the form of taxation, yet still believing that in due time all wrongs will be made right. They depend largely upon your Board for leadership in the great agricultural industry in which they are engaged. Let their confidence be justified by your continued exertions in their behalf.

Gentlemen, the Franklin County Agricultural Society, yes, all the people of the county, bid you a most cordial welcome. The doors to our hearts and homes are wide open, and we bid you walk in. May your stay among us be both pleasant and profitable.

Chairman Grinnell. The response from what is in the heart of every one of us will come from the Board through Mr. George E. Taylor, who represents the Franklin County Agricultural Society on the Board of Agriculture.

Mr. George E. Taylor. Mr. Chairman, it gives me pleasure in behalf of the Board to reply to the friendly greeting extended to this organization by the president of the Franklin County Agricultural Society.

It makes the heart leap with gladness when the warm grasp of the hand of a friend bids one welcome to his home. So now the Board rejoices at the welcome extended by our host, and we rest in confidence that the kindness, courtesy and hospitality will be generous.

The visits of this body of men are not frequent; it is seventeen years since it gathered in this place, and this is the third time only in the existence of the Board.

While the State and nation have always recognized the importance of the husbandman as a factor in the nation, they have been slow to encourage that branch of industry. Not until the present century had any organized effort been made to encourage a scientific education for the farmer. The elements and nature kept their secrets. The nation at

peace, the people prosperous, learning increased, scholars became interested in solving the mysteries of chemistry and of plant life. The investigations of man having unfolded some of the wonders of nature, farming became an interesting and honorable occupation, and from its ranks have come illustrious names on the pages of the world's history.

Thirty years ago Senator Morrill of Vermont, amidst great opposition, carried through Congress a bill for the promotion of agricultural education. Since that time this subject has received marked attention. By act of Congress all the States have received grants of the public domain for advancing education along scientific and agricultural lines.

To-day we bring to the people of Franklin County the best scholars of the country, aye, from beyond the sea they come, and lay at our feet the wealth of learning and experience of the present and past history of the agricultural ages.

Again we thank you for the warm welcome extended to this Board. We are glad to come as guests of one of the most successful agricultural societies of the State. We are glad to come to one of the most beautiful of New England villages. We rejoice to come to "little Franklin," whose noble men and women have been born and reared for the State, the nation, the world and for God.

Secretary SESSIONS. I noticed, in the list of men who have represented the two agricultural societies in Franklin County, Mr. Smith, in his modesty, omitted his own name. He has represented both societies on the Board of Agriculture, I think one of them more than one term.

Mr. SMITH. Yes, gentlemen, and I feel quite at home in your presence. Now, as chairman for the day, it becomes my duty to call for the first lecture upon the programme, which is on "Growing timber as a crop on the waste and other cheap lands of Massachusetts," by Hon. J. D. LYMAN of Exeter, N. H.

Growing Timber as a Crop on the Waste and Other Cheap Lands of Massachusetts.

BY HON. J. D. LYMAN, EXETER, N. H.

Mr. Chairman, ladies and gentlemen: Up in New Hampshire we consider the last thing a person can do is to "take to the woods," but it seems that Mr. Sessions, at this session, proposes it as the first thing to be done after the preliminaries.

I do not come here to tell you anything new. I come simply to invite your attention to that which you undoubtedly know as well as I know, although perhaps you have not given it that intense attention which I have. I come to save that which has been lost, for, according to the census report of 1880, more than one acre out of ten in your farms has been turned out as waste, as dead land, so to speak, and this amount is nearly equal to one-fourth of your entire forest area. Now, I come to ask you to apply science and common-sense to the production of timber on these and other cheap lands. You know the savages leave everything to the production of nature. Instead of growing cows and steers and pigs and sheep, they chase the deer and bears and hunt coons and woodchucks, and live on the wild products of nature.

A few years ago it was a very common thing in our section of the country, and I believe in Massachusetts, for the boys and girls to trample down acres of grass and spend days of time to get a few quarts of small strawberries. Now in a few minutes we go into our gardens and pluck them by the bushel. That is science and sense applied to the cultivation of the strawberry.

Now, we have never, with very slight exceptions, applied science and sense to the production of a crop of timber, and

I think it is very strange indeed, — strange, since you can grow timber as well as you can grow corn. The first man's first work was to take care of the trees which God had planted for him, yet the majority of people to-day think that the best care of a forest is to let it alone. An agricultural editor a short time ago told me that he had an area of young pines, and he would as soon have an elephant in his flower garden as a man with an axe among those trees, — contending that nature is the best forester. But nature, with all the time since the flood, had produced in this region now known as New England perhaps five thousand feet, mostly poor timber, to the acre, that was found here by our Pilgrim ancestors. About five thousand feet to the acre is the crop of timber presented by nature in the great primeval Michigan and southern pine regions and in the spruce region of northern New Hampshire. Now, I contend, and I do not go quite so far, perhaps, as my brother, Mr. Hersey, that, by exercising common-sense and care, a man can, in from forty to sixty years, grow from forty to fifty thousand feet of good pine timber to the acre, — grow ten times as much, if you please, in a hundredth part of the time, as nature had to show our first settlers. There is no crop, *no crop*, that will feel the touch of the hand of science and of common-sense applied to it quicker than will the crop of timber. You can not only grow trees of the species that you want, but of the shape you desire. You can mould them almost as the potter moulds the clay.

One of the fundamental principles in all agriculture (the same is true in the science of forestry) is to get the proper number of plants to the acre. You can plant your corn so thick that you will have no crop. You can sow your grass seed so thick or thin that there will be little to mow. You can have your pine trees so thick that after a hundred years they will be only the size of fence poles, or so scattering that each will be a pyramid of limbs.

You have in this State, according to the census of 1880, 226,669 acres of land that you have turned out as waste. I wish to assure you that that land is not dead; it is not necessarily barren; that it will produce, if you will only put it into the right crop. As politicians are all telling

about returning to first principles, you want to return to first principles, and the crop demanded in this case is a crop of trees. This is philosophically true, theoretically and practically true.

Take the pine, for instance. It takes its sustenance almost entirely from the atmosphere. It is like the saints, — it has very little of the earth about it. It is among the most upright of created things. It lifts itself into the air, and through its leaves absorbs from the atmosphere that poisonous carbonic acid gas that we are throwing into it every time that we exhale our breath, which is ever rising from decaying vegetable matter, and from every fire, and which would poison the air but for this elementary action of the plant growth. The pine, through its leaves, absorbs this carbonic acid gas, exhales the oxygen, making the air fit for us to breathe again, and retains the carbon for its growth. It is true that some of this gas is brought down by the rain and the snow and is absorbed by the trees through their roots, but undoubtedly a far larger proportion is absorbed through the leaves, and perhaps the leaves are more emphatically the mouths of the plant than they are the lungs. Pines take a little pinch of earth, largely as potash. Burn, if you please, an acre of pine wood, and that which it took from the atmosphere returns to the atmosphere. That which it took from the earth remains in ash, and you know how very little it is. Hence it is philosophically, theoretically and practically true that poor land, so called, will produce good timber.

I speak especially of the pine (*P. Strobus*) because it is the most valuable of our timber trees and because a greater proportion of your waste and cheap land is better adapted to the growth of pine than to other good timber trees. It will grow in a swamp or on sandy barrens. It will grow almost everywhere. It requires of the land a firm foothold and a little water to drink. Now, you take almost any of the waste land here in Massachusetts, in this climate, just on the sunny side of the midway line between the eternal heats of the equator and the eternal ice of the pole, here where you have forty or more inches of annual rainfall, — and you have practically no land but what will,

with this rainfall and sunshine, produce a magnificent crop of timber.

Speaking from my own experience, I will give a small example. In 1870 I bought an abandoned farm. Some one, two or three years afterward I noticed a clump of sapling white pines upon it. I had no recollection that I had ever seen them before. It covered one hundred and eight square rods of land. I could not have sold that acre of land, including those pines,—and they were right beside the road,—at that time, probably, if I had advertised it throughout the section for a dollar, to any man living. After I noticed them I asked a friend of mine if he did not want some bean poles, fence stakes, etc. He had enough of his own farther away, but concluded to take mine for the cutting. I showed him how I wanted him to thin out the trees. Told him to pay no attention to the body but to the head of the tree, and leave only those which had a fair-sized head and a single stem running right straight towards the heavens. I was there the next year, and found that he had thinned them out just as well as I could. I did not see those trees again for five or seven years. Then I found I had neglected them too long. The trees had grown faster than I expected, and you have little meaner land in Massachusetts than that is. I found that the trees were too crowded. Pine trees grow rapidly in proportion to their leaves. I asked him to thin them out again. He has thinned them from that time to this, and I presume he has cut out nearly as many cords of wood as the trees now standing contain. He has not only shingled his own buildings but many of the neighboring ones, and has built two stables in the village, mostly out of timber cut from that lot. I have been there two successive years to measure these trees. Mr. Carey, an agent of Mr. Fernow, chief of the United States Forestry Bureau, and I, measured them on the twenty-third day of June, 1894, and I measured them on the twenty-third day of June, 1896. I find that they are growing at the rate of over two thousand feet of inch boards yearly, by the acre. I cut two carefully selected trees, so as to get the average size, and had them sawed with a common thick circular saw,—one of those

wasteful things. Those two trees made five hundred feet of inch boards. Now, if my judgment is good (it ought to be, for I was almost brought up in the woods and in a saw-mill), that clump of pines will make at the rate of fifty-four thousand feet of inch boards to the acre. The trees now average over thirteen inches in diameter, four feet from the ground, and, of the two I cut, one was eighty feet in height and the other seventy-two feet six inches. I have had the trees trimmed so that there are no limbs within twenty feet of the ground. I think no one will deny that that timber is worth five dollars on the stump by the thousand, and if there are fifty thousand feet,— and I have no doubt but there are more, — it is very easy for you all to see how it has gained in value since I purchased it, when I doubt if I could have sold it for a dollar an acre. When these pines are cut off and that land is left, you can buy the land for fifty cents an acre. I mention this simply as a sample of what can be done. I judge the average age of these pines to be fifty years. They ought to have been thinned earlier and oftener, and consequently been larger.

You recollect Mr. Jewell, speaker of your House of Representatives. His brother, living in New Hampshire, gathered twelve bushels of pine cones and scattered them over the grass sod of two and a half acres of worn-out pasture land. This was in the autumn of 1849. I went there in 1891, and saw one of the handsomest pine groves that I had ever seen. Two trees were cut so that we could arrive at correct conclusions, and I concluded that the trees averaged sixty-six feet in height and eleven inches in diameter four feet from the ground. Now, that land when those trees are taken off may possibly be worth one or two dollars an acre, at the market price there. These trees would have been larger if they had been thinned earlier and oftener.

But one of the best examples, indeed, the most interesting I know of, is in your own State. I have been twice to Enfield, Conn., to see the pines sowed by Omar Pease. He was a Shaker. I saw various places on these plains where there was no sod on the ground whatever, although most of the plains uncovered by pines had a light sod. He ploughed the land and sowed it to rye, and harrowed the rye in. Then

Trees trimmed and cared for. Taken some three years ago. Average age, fifty years. Land mowed in 1835 and for several years afterwards. (See page 26.)

he sowed two quarts of pine seed to the acre broadcast. Then he rolled the land, and the result was a splendid catch of pine. I refer to the white pine. He followed this for a number of years, until he had some one hundred and fifty or two hundred acres in pine. Later he sowed one quart of seed to the acre. Those trees are not as good. They are farther apart and have a good many limbs low down. Some successor of his — for he passed away — ploughed up forty acres of these pines, among the last sown by Pease, because he thought he could raise rye on that ground. His rye did not materialize, and the land for many years has lain idle. By the way, I would advise any of you who are interested in the subject to go there and see that magnificent growth of pines upon that extremely poor plain land. Most of these pines are said to be on the Massachusetts side of the State line, and exempt from taxes the first twenty years.

I catch the eye of my friend Pratt sitting before me. Probably most of you know that he planted thirteen acres of poor land (I suppose it was poor, because he said it was covered with huckleberry bushes and weeds) to pines The planting cost him eight days' work. He planted in hills, digging little holes among the weeds and blueberry bushes, and putting in pine seed. He has cut some of those trees, and you see he is not a very old man yet, notwithstanding he parts his hair by a little bare strip in the middle. He wrote me a few years since, when he was cutting those pines, that he was getting more than forty cords of box-board logs to the acre, and the trees were forty years old. He was selling those logs at six dollars a cord, delivered. They were measured as wood is measured, and not scaled as logs.

I do not come here for the sake of talking. I come here to ask you to plant your waste land with forests. You send your money to your sister States for lumber; you even send it to the British Dominions; and still, according to the census report, you have more than two million one hundred thousand acres in forests, and you have more than a quarter of a million acres of land lying idle that has once been pasture or field. This forest and waste in proper condition would annually grow from five hundred to one thousand feet of boards for every person in the State. Now, there is no

reasonable doubt that by far the larger per cent of that land, nearly all of it, probably, would grow valuable timber. I do not say that white pine would be the best and most profitable tree to grow on every acre of it. The chestnut is in some instances a more profitable tree, especially on account of its being so early useful for posts and sleepers. By the way, the census report says that this land, this waste land, is increasing each year, that you are yearly turning out more of it.

Suppose I stand facing my deserted farm referred to. Much the better portion of my farm is on my right as I stand facing this little clump of forest trees. It is by far the better portion of the farm. I would be glad to sell it to-day for a dollar an acre. It has been idle and unused for the last forty or fifty years. It is too far from my home for me to utilize it. Take the land on my left. That land is covered with growth that has never had any attention given to it. It is all scrub pine. I can stand on the ground and cut branches from it as large as my limbs. In that little cared for clump there is not a limb within twenty feet of the ground; every one of the bodies is smooth, and the butts will all make excellent boards when they are sawed. This illustrates the difference between utilizing land and leaving it alone to nature.

I wish to say another thing. I spoke about trees standing close together. In the city of Dover a few years ago I saw a man cutting down one of the handsomest pine groves I ever saw. It was on excellent land. I asked him why he cut them, and he said, "Look up; they have not tops enough to grow into timber trees, so I cut them for wood." His loss by not thinning was more than the wood brought.

Now, here is a pine [specimen shown] that started slowly, and the poor thing got shut out from the sunlight and the air. You see it had more air on one side than on the other, more sunlight on one side than on the other, — very much more. It did the best thing it could do, — it grew one-sided, and then concluded to die. It was suffocated. My friend Hersey will tell you that he can grow good-sized box-board logs from the seed in thirty years. Here is a pine of seventeen years' growth, so crowded that it is only about

Trees that have not been trimmed and cared for. A few years older than those in other picture and on better land.

an inch in diameter. Here is another tree in the same condition. The pine is very peculiar. It is as careful as any member of the aristocracy of England in keeping its age. In 1896 this pine has grown from where my fingers are. A pretty good growth for one year. Last spring that existed, as you may see, in embryo. There is a bud for the next year's growth. In the year 1895 it was there [pointing to height of tree in 1895], in the year 1894 it was there, and in the year 1893 it was below there [showing by the pines he had on the stage their age and how much they grew each year]. The pine is very careful how it keeps its record. You count the grains or the rows of limbs, and you will find one, two, three, four. That pine was growing at a pretty good rate. I have frequently known them to grow from thirty to thirty-six inches in a year. A member of our Board of Agriculture told me that he found a pine that had grown four feet in height in a year.

By the way, the pine has its enemies, like everything else. There is a tree [specimen exhibited] some twenty years old or more. There is a weevil, and when in its fly state it lays its eggs at the base of the central bud at the top of the tree. There is a bud there with a lot of buds around it. There were four buds from which these branches started last spring, and this central bud was that from which this grew. [Mr. Lyman was here illustrating from a pine he had in his hand.] The fly lays its egg at the base of the central bud. If it would only lay its egg at the base of some of the side buds, it might do good. It knows how to do the most evil. The eggs hatch and the little worms eat into and up through the central growth, which is the stem or body of the tree, and kill it, and the lateral limbs then grow and make a branching top. The tree in that case becomes branching. [See specimen.] I have never seen the pine weevil very far from the sea coast. I see very little of it fifteen or twenty miles from the sea coast in our section. This specimen might have been killed from some other cause, but the weevil operates that way. Here is another tree [showing dead pine]. That did not have enough of sunlight and air. Now, here is one that had too much, and it had them largely on one side. It kept a good record of the conditions in which it grew. This

had sunlight on one side, and grew one-sided. In addition, it had another misfortune. It was whipped on the head by a limb from another tree. We have a great deal of trouble with the little gray birch. It whips the tops of my pines. I can show you a pine that stands at least twenty feet from a gray birch, and the birch has bent over and whipped it so the tree, after it gets up to twelve or twenty feet, grows branching and on one side. By the way, the little wild cherry is one of the worst trees to whip the young pines. If your pines are scattered in cleared land they will be worthless. I have had pines eighteen inches in diameter whose live limbs lay on the ground. They rose like a pyramid. If pines stand too thick, they will be almost worthless. If they are too scattered, they will be almost worthless. Indeed, scattered pines are nearly worthless even for wood, because you cannot easily fit their bodies into fuel. The limbs, of course, make pretty good wood. By the way, the pine, as well as other trees, is a good record keeper of the weather. In better years it makes greater growth. The quality of the years depends on the amount of warmth and moisture. Sometimes the winter will freeze the trees so hard that they will not grow as well the next year. Go into the White Mountain region of New Hampshire and cut down the old spruces and count back the annual rings to 1816, when there was a frost every month in the year, and nearly every night. The trees made very little growth that year, and very much more growth other years.

The pine blossoms early in the spring. When I was a boy I used to see the pollen from the staminate flowers on the puddles, and supposed it was sulphur. The year the tree blossoms the cone grows three-fourths of an inch in length, and a little smaller than the end of my little finger. It starts very slowly indeed. The next year it grows very rapidly, and by the first of September you should gather your seed. The cones must be gathered before the scales open, because the seed will drop out almost immediately. It drops out more rapidly than chestnuts or walnuts after their burrs or shells open. Gather the cones early, and place them in a dry, cool place, spread thin, and in ten days the cones will open and you can beat the seeds out. I would

advise you to sow them early, for fear they would not keep well.

One thing more, and very important, — you must have your trees come up thick. If they come up far apart, they will be too branching and of little value. You want the low limbs to be very small, and the only way to have them small is to have the trees come up very close together, I should say not less than three thousand to an acre, and I would rather have six thousand. You want to begin early to thin them out, because the tree will not grow unless it has space. Thin not too much at a time, but often, and select your standards and thin about the standards so as to keep them growing. On my dry ground I intend to keep the live tops large enough so that the trees intended for good-sized mill logs will gain two inches in diameter in five years. The growth of a tree will depend on the size of its live top. You can cut off the dry limbs as they die, and sometimes a few green ones. I found by experiment that it would cost about one and one-half cents a tree to trim them up to twenty feet from the ground. You can see at once, if the limbs are cut up twenty feet, by the time the tree is three inches in diameter you could have large logs entirely free from knots to within one and one-half inches of the heart. At the butt of the tree you can cut all these limbs when the knots are very small.

If you are going to grow lumber of good size, why not grow valuable lumber? I intend, when my little pines are grown, that the lumber will bring the highest market price. Passing through our village the other day, I asked the price of pine lumber. One gentleman told me that he was delivering inch box boards at Haverhill, Mass., at nine dollars a thousand. I came along to a planing mill, and asked what their pine boards were worth. "About ten dollars a thousand." At another place I asked, "What is that lumber worth?" "Twenty-four dollars a thousand." I came along to a carpenter and asked what his lumber was worth. "Sixty dollars a thousand." All pine lumber, but of different qualities. You can grow the valuable lumber by a little care. The same principle of care extends through all departments. The red knots of live limbs are fast. You cannot knock

them out, but when a limb dies it ceases to grow and the body of the tree grows out over it; the limb turns black, and when you saw the lumber you find a black knot, and it is apt to be so loose that it will drop out. That could all have been prevented by cutting off the limb in its early stages.

Mr. Pratt (of North Middleborough). In cutting off a growing limb, the turpentine oozes out. Is that any injury to the tree?

Mr. Lyman. I do not believe it is, but in some instances there may be in one board some turpentine. If you have your trees stand thick enough, you will not have to cut off many live limbs. They will die when small. Some say that wherever you cut off a limb there will be a rotten place; but a man who was brought up in a saw-mill knows better.

Question. Then you would cut only dead limbs?

Mr. Lyman. Sometimes I would cut live ones. I would be sure to cut all the dead ones, so far as I thought it would pay. I should probably cut them up thirty or forty feet, if I were a young man like yourself, but at my age probably not over twenty feet. I have fixed a saw that I can stand on the ground and use up twenty feet. Here is a block from a tree that was growing at the rate of over an inch in diameter a year. You know just as well as I do that that tree had an immense top and large space. They sawed it through at the butt, and went off and left it standing. They went back an hour or two afterwards, and it was still standing. The lumber answered for various purposes, but it was too coarse.

Here is a section cut from the butt of a tree only three inches in diameter. It was examined under a glass, and it was concluded that the tree was ninety years in growing, while I know of a tree ninety years old that is more than three feet in diameter, and my friend Hersey knows them still larger of their age. By the way, I might say that a dead limb not bigger than a pipe stem may stay on a tree fifty years after the limb dies, and there will run far into the tree that dead black knot. The little dead limbs are very persistent in staying; they run right through to near the heart of the log.

Now, gentlemen, I wish to say to you that it is my firm

conviction — I know it from experience, from observation, and I believe in it from the philosophy of things — that you can take these two hundred thousand acres of waste land in this glorious old Commonwealth, and in a few years clothe them with the rich vesture of a timber forest that shall be worth hundreds of dollars per acre, even at the present low prices, and that in the aggregate will add scores of millions of dollars to the property of your State, and greatly increase the beauty of the landscape. Many believe the influence upon the climate, as regards temperature, rainfall and healthiness, would be of immense importance.

Gentlemen of the worthily famous Old Bay State, it is not fitting that you let more than a quarter million acres of your old homesteads, once covered with trees and then with farm crops, lie lifeless and worthless barrens. These lands are not necessarily barren, they are not dead; they are simply in coma, and need but the touch of the true forester to spring into life as did the son of the widow of Nain at the touch of Jesus. Park the barrens with timber forests, and future generations shall bless your memories.

The Chairman. Now comes the very interesting part of the meeting, — the discussion of the lecture. The lecturer is ready to answer questions.

Mr. Pratt. To just what distance apart would you advise us to thin our pines, in order to get the best results in growing them for timber?

Mr. Lyman. It is impossible for me to answer that question. I have been studying that problem for years. Mr. Fernow wrote me that my pines were past redemption, that I had not one where I ought to have four. They at fifty years of age stood two hundred and sixteen per acre. When Mr. Cary came and measured my pines he told me he had found none equal to them at their age. It will depend a great deal upon what kind of timber you want to grow. If you are going to grow mast trees, you cannot grow many to the acre. You can grow a great many more box-board trees. In some sections it would be profitable to put the trees you cut out in the thinnings into the various uses for which their size fits them, say first thinning into kindling

wood, then into stakes and fence poles, then shingles and box-boards. My own idea a few years ago was this: that when forty-five years of age I would have my pines thinned down to one hundred trees to the acre, and that I would expect that in fifteen years from that time, when they were sixty years of age, they would make five hundred feet to the tree, — I mean inch boards always. That is fifty thousand feet to the acre. I am satisfied that I can do that, and more too, but perhaps that is thinning them a little too much; I am not certain of it. By cutting out thirty of these trees and leaving about seventy to the acre, in twenty or twenty-five years they would make a thousand feet of inch boards to the tree, and there would be something like seventy thousand feet of inch boards to the acre. Then, by cutting out twenty-five or thirty more, and letting them stand thirty years longer, I conclude they would make two thousand feet of inch boards to the tree. They will vary on different lands. You will grow more trees to the acre probably on dry land than you will on moist land, because they will be smaller. My experience is not like Brother Hersey's, — that poor land will not grow large pines. It certainly does, and has, in New Hampshire. There is no question about that, so far as my observations go. Generally speaking, I think where the land is dry the trees grow slower than on moist land. In my brother's pasture was as poor land as I ever saw. The railroad took off six feet of the top of that ground and left the open sand, and that is now covered with thrifty pines. That was thirty or forty years ago. If the ground is over dry, I should not expect the pines to grow fast; but I think there would grow rather more and smaller trees to the acre in a given number of years. One forester in New Hampshire says he can grow one hundred and sixty pretty good timber trees to the acre. You can grow more to the acre than you expect to cut at once, and by cutting out the biggest have a succession of trees coming to maturity. This may be the best policy in some cases.

In 1854, when I was sick on my bed, I bought, with my uncle, land that had been lumbered a few years before. I knew nothing about the lot. We gave six hundred dollars for it. When I got up they laughed at me; said everything

was cut off from it. The land was poor and the deciduous trees small. There were scattering pines over the lot of a hundred acres. In the next fifteen years I sold off from that some three thousand dollars worth of white pine lumber. It had grown from the little trees left by the lumbermen.

The best number of trees to grow to the acre would depend much upon your market and on the kind of lumber you wanted to grow. As for a specific statement for any case, I cannot give it. I have studied the question for years, and am studying it yet.

Mr. B. P. Ware (of Marblehead). Is it practicable to transplant seedling pines?

Mr. Lyman. The other day I went to visit a plantation where the late Isaac Adams set out pines, and they were doing admirably well. The trees were some six or eight inches high when he transplanted them. He hired boys to collect them. Douglass & Sons have covered hundreds of acres with pines from their nurseries. The only trouble in growing pine from the seed is that the hot sun is apt to kill the tree in the first year or two of its growth, and it needs a little shade. Therefore I was particular to say that the Shaker sowed rye for shade. My friend Pratt planted land that was covered with huckleberry bushes. I think I would generally sow rye. If I had rag-weed seed I would sow that for shade. I would in some cases plough, setting the plough at the west and running it to the east, and plant the seed in the south side of the furrow, so that the shade of the furrow would fall upon it, and sow rye in the furrow. I planted pine seed in very poor, dry grass land, turning a little bit of turf to the south and planting the seed close to the south side of the hole, to have the turf shade it as much as possible. On some of these bits of turf I put a stone to increase the shade. Where I put the stone I got a pine, one or more (I put three seeds in a place), and where I did not put a stone I got but few pines. An early severe drought may have been the cause of my partial failure.

The Secretary. Your talk has been confined to the white pine?

Mr. Lyman. Yes, sir. But the same general principles

apply to all timber trees. By thinning thick young growth, where growing fire wood, you will get many more cords of wood when it is of good size for the market.

Hon. John E. Russell (of Leicester). This is a very important subject, and I regret that the Board has not time to discuss it in full this afternoon. I judge, from the questions that are asked here, that it is a question that would bear discussion. Now, my friend Mr. Ware asks if it is better to procure seedlings of white pines rather than to plant the seeds. Mr. Manning of Reading, one of the best foresters in the United States, said that he once supplied a man with two thousand yearling white pines, and every one of them perished, owing to the manner in which they were set out; and Mr. Manning, who was a nurseryman, considered it much better for a farmer going into this branch of husbandry to sow the seed of pines and to gather his own seed. He also thought it best to begin with five hundred trees to the acre, and gradually thin them out.

There is no doubt that this is the home of the white pine. Massachusetts, New England, indeed, is the home of the white pine tree, and it is the best, most useful lumber that ever was offered to the service of man. It grows readily with us, and, indeed, so do all trees. The State of Massachusetts, except Carolina, is the best part of the United States for forestry. We have some examples in Massachusetts to which attention might be drawn. Down at Wood's Holl Mr. Joseph S. Fay has the most splendid example of trees in the eastern part of this country, and perhaps on the Atlantic coast. Mr. Fay raised a great number of his trees from the seed. He has a great variety of trees there. They have grown with a great deal of vigor from the seeds, and it is a magnificent plantation.

Men have greatly enriched their families by planting trees. *No man will enrich himself by planting trees, and that is why our farmers do not plant them.* We do not have a sufficient fixedness of purpose. We are looking to go into some other business, to leave the farm and go somewhere else, and that is one reason why we do not plant trees. The farmers do not expect to eat the fruit, and that is why they do not plant fruit trees. They do not work for the future.

A most remarkable instance is that of a family by the name of Athol, who owned a large tract in Northern Scotland, ten thousand acres of miserable land, as poor as anything in New Hampshire, where the lumber had been cut off. The family was very poor, and it is said that the man commenced to plant Scotch larches. It is said that he planted a million or more a year, two or three million, perhaps, of trees a year; at least, he covered some forty or fifty thousand acres of land with the Scotch larches, and greatly enriched that family. They built ships entirely of those larches.

The larch is one of the finest trees that we can raise in Massachusetts. We need not be confined to white pines. My neighbor, Mr. Hadwen, once wanted some pieces of timber in building a barn. Out of a row of trees which screened his land from the main road going into Worcester were twenty Scotch larches, which squared eight inches at the small end and thirty feet long, that he had planted there himself, and that had grown there almost unobserved by him. He did not cut them nor think of them until he had visited every lumber yard in the region to try to get lumber of this size.

Mr. Pratt. I wish to take a little exception, when he says that men will not plant to enrich themselves.

Mr. Russell. Your family is the only exception.

Mr. Lyman. How about the larches you mentioned?

Mr. Pratt. I have for several years received my spending money from cutting trees for pine lumber, raised from seed that I planted with my own hand. For the last seven years I have been cutting from year to year an acre each year, which will produce from forty to fifty cords of box logs, averaging five and one-half to six dollars a cord, beside pine wood, which does considerable towards paying for the cutting. I have to-day a piece containing five acres which I would be pleased to have any gentleman look at, which I have not yet cut, that I had the curiosity to examine last week and measure some of the trees. Of course I picked out good trees, of large size. Some measured six feet and six inches in circumference, others from five and five and a half to six feet.

Mr. Lyman has recommended an excellent plan for trimming trees. But nothing has ever been done, nothing has ever been laid out upon my trees, except the expense of planting pine seeds forty-eight years ago. If some gentleman should offer me one thousand dollars for those five acres, I should refuse the offer. I believe I can get more money by having it cut, doing none of the labor myself. I believe there are sixty cords to the acre on one or two acres.

I have been intensely interested in the essay. I believe what Mr. Lyman has said here to-day is just what the people of the State of Massachusetts ought to do with these abandoned lands which we have heard so much of in late years. If pine seed were scattered over them, they would be a source of income, if not to the present generation, then to their children.

In regard to Mr. Ware's question: within one and one-half miles of this lot of five acres, which I said I would not take one thousand dollars for, there are some twenty or twenty-five acres which another gentleman employed a nurseryman to plant to pine trees when they were about two and one-half or three feet high. I think every one of these trees lived. I looked that lot all over with Mr. Austin Carey, and it is in a condition that is not desirable to have. The trees have branched out badly. I think, from the light I have received from Mr. Lyman, that the cause may be the worm he has spoken of. By cutting off the top it has caused these branches to come out. That lot of twenty or twenty-five acres is to be sold at auction next Saturday, and I am told by good judges of lumber that it will not bring one thousand dollars; that only a small part, if any, is worth anything for timber, that it must be put into fire wood. That is an illustration of transplanted pine trees. It is within a mile and a half of the five acres that I planted myself. I have cut off most of the land that I have planted and got some spending money, and the spending money is gone.

Mr. Geo. Cruickshanks (of Fitchburg). Mr. Russell has referred to the planting of larches in Scotland. There are nurserymen in Great Britain who make a business of

growing these trees for that special purpose. When I was a boy, eleven or twelve years old, my father had charge of planting a large amount of forest for a university in Glasgow. The system of planting there may be somewhat different from what it is here. A man sticks a spade into the ground, takes it out and puts it in again at right angles with the first insertion, turns up the sod, puts in the tree and presses the earth down. You can see, gentlemen, that it is a very small matter to plant trees in that way. That is the way planting for forests in Scotland is done. I can well remember taking a bunch of these larches, and, boy that I was, sticking each one into a hole and putting one foot one side and one the other, and the tree was planted. There was an immense income from those forest plantations.

Mr. WARE. I would like to ask Mr. Lyman what is to hinder trimming off all but one branch from the trees where the worms have gnawed off the bud, and having a tree grow from that?

Mr. LYMAN. Nothing whatever, only, if it is up twenty feet, it is rather troublesome to do.

Mr. WARE. But in the case spoken of it occurred when the trees were small, so that it would be very easy indeed to trim to one leader.

Mr. LYMAN. I think usually in our section the weevil works on trees from five to twenty-five feet in height. I would say in relation to what Brother Pratt has said, that the transplanting did not cause the insect to ruin them, — had nothing to do with it. I would say, further, that you must plant your trees near together if you want to get good timber, otherwise they will be all full of black knots. I wish to say that the man is living and vigorous who mowed over the ground where my pines are growing, and they are pretty good timber now.

Mr. RUSSELL. He planted them?

Mr. LYMAN. No, they were not there at that time. I asked how about the larches that you spoke of yourself?

Mr. RUSSELL. That was a man who was willing to work for the future.

Mr. W. A. KILBOURN (of South Lancaster). How can we protect our plantations from fire? I have the care of

several acres of transplanted trees, which are very handsome. They were carried in a little express wagon from a neighboring forest, planted in May with a little sod around them, and I think every one of them lived. They are now trimmed up twenty feet high, and I fear the same fate may happen to them that has happened to thousands of acres in our town, — that they may be burned over some day. We have in the town of Lancaster thousands of acres that were burned over last spring. The wood that could be gathered from these acres would just about pay the chopper for cutting, and it must be cut and removed or the future growth will be in poor condition. The statements that have been made in regard to the pine are all very true and very encouraging, but the discouraging or troublesome part is the fires that we have to contend with and from which we see no escape. They come from sparks from the railroads, sparks from gunners and particularly smokers, and the owner of the land is absolutely helpless.

Mr. Lyman. I have no patent way of preventing fires. I have been very fortunate; have had only two, and they were very small, — did not injure me over fifty dollars. When I was a boy and worked in a saw-mill there were a good many butt logs that showed that the trees had been injured by fire.

Mr. Stetson (of Lakeville). What amount of seed would Mr. Lyman sow to the acre?

Mr. Lyman. I would plant the seed about as thick as I do corn, — about the same distance apart. If I were going to sow the seed, should use two or three quarts to the acre. Sow thick and thin early and often.

Secretary Sessions. What is the best thing to sow with pine seed?

Mr. Lyman. With my present knowledge I would sow it in the fall, and with winter rye. On plain land I would roll the ground. I would follow the example of the Shaker who succeeded.

Mr. Pratt. Would n't you sow the rye very thin indeed?

Mr. Lyman. I am speaking of land that would not grow a heavy crop of rye. I told you I came to save that which was lost. I would not sow very thick.

The Chairman. I think perhaps it is time we drew this discussion to a close, from the fact that we are to have another lecture this afternoon, from a representative of the Weather Bureau. So, if there is nothing more that is essential on this very interesting subject, we will consider it closed. I now have the pleasure of introducing to you Mr. J. Warren Smith of the Weather Bureau, who will speak on "The weather and its influence on man and the productions of the earth."

The Weather and its Influence on Man and the Productions of the Earth.

BY MR. J. WARREN SMITH, BOSTON.

"Never try to do business with a man when the wind is from the east," is an old New England saying and may be aptly applied to the northern Atlantic coast, where the east or north-east winds bring all the chilly dampness and penetrating cold of the Arctic waters.

It is certainly true that weather changes affect every one to some extent. Most people feel depressed and irritable in disagreeable weather, and correspondingly exhilarated and amiable during clear, fine, anticyclonic weather; but whether it is due to the moisture in the air, the temperature, or to the atmospheric electricity, no one can determine. The northern lights are certainly most brilliant and active during clear, cool weather, and all substances are most easily electrified, so why may not our whole system be so charged with electricity as to invigorate us to an appreciable extent?

An interesting article in a recent number of the *Medical Arena*, by Mr. Patrick Connor of the Weather Bureau, treats of the relation of the barometer to death. Investigations at a near-by hospital, where records of the exact time of death are kept, showed that deaths occur in greatest number from midnight to 2 A.M., with a second maximum from 5 to 7 P.M. These periods correspond almost exactly with the two daily minima of atmospheric pressure, but it should be added that the studies cover but a short period of time and that there were but few deaths in that time. It would certainly be interesting to have further observations carried on in this same line, and also to see if there is any relation between the death rate and a falling barometer, due to an approaching storm, or a rising barometer, with the approach of fine weather. Mr. Connor asks a number of interesting ques-

tions, which may well bear further study: "If the causes are not traceable to atmospheric conditions, might they be ascribed to the absence of the electro-magnetic conditions which produce daylight?" "Would the use of artificial means at night have any perceptible effect in stimulating the organism of a patient whose critical condition requires more of a vitalizer than rest?" "In cases where medicines have been abandoned and certain treatment is being used for the sole purpose of prolonging life, considering that when certain forms of electro-magnetic energy are exhibited deaths are less frequent, would the introduction of strong electric light to dispel darkness and its attendant morbidity be an auxiliary?"

Man is affected mentally and to some extent physically by the *weather* changes; but the factor that really determines whether a person can reside in any given locality, and controls the growth and variety of vegetation, is *climate*.

For example, an excessive rainfall for one or two seasons may cause a luxuriant growth of vegetation on land usually somewhat barren, or a succession of dry seasons will enable one to work and cultivate land usually too wet for the plough, while it is the average rainfall for five, ten or fifty years that determines the agricultural value of the place. Records show that because of a succession of wet seasons, settlers have pushed out into some parts of Kansas and Nebraska that are usually semi-arid, and that with the one or two dry seasons the crops have failed, and the land must needs be abandoned, or else irrigation be resorted to.

The climate of any section depends on the temperature, moisture and wind. For temperature we must consider monthly and annual means, the mean diurnal variability, the monthly and annual extremes, the average dates of the latest and earliest frosts, the mean intensity of the sunshine and the extreme temperature of the soil at various depths. Complete and valuable monthly and annual isothermal charts of the world have been made, and from them we find the temperature decreasing from the equator toward the poles, but very irregularly and variably, especially in the northern hemisphere. We find that the decrease in temperature toward the poles is most rapid over large land areas and

least rapid over water areas; also that in the same latitude it is colder on the eastern side of the continents and warmer on the western, due to the air and ocean currents. The most equable temperatures are found near large water areas, and the places of greatest absolute ranges in temperature are in the centre of large land areas. It is found also that, while the region of greatest cold in the northern hemisphere is around the pole during the summer months, it is not there in the winter, but there is a marked cold pole in northern Siberia, where the mean temperature for January is — 60°.

In determining the climate of a place in reference to its moisture, the most important data are the mean monthly and annual fall of precipitation and the mean frequency of rainfall in each month. A district may have a large annual fall of rain, yet be worthless from an agricultural stand-point, because the rain comes in a few heavy storms, or there may be wide intervals without rain when droughts prevail. Even when rain comes with a fair regularity of fall, if the average annual amount be under eighteen inches, agriculture can seldom be safely practised without irrigation, and grazing becomes the leading occupation. When the average fall is less than twelve inches, the region is practically reduced to a desert, and generally the water supplies are too small to be of benefit in irrigation.

But, on the other hand, if the rainfall of a district be over one hundred inches, the vegetable growth is generally so luxuriant that the land is occupied and worked with difficulty. The rainfall over most of the temperate zone of the northern hemisphere is from forty to eighty inches, the amount being greatest in southern sections and decreasing with a fair degree of uniformity toward the north. It is interesting to note that, in regions where the temperature is best fitted for human existence and for the best development of all the human faculties, the amount of rainfall is also that under which human occupations are best developed.

The wind values that go to make up the climate of a place are the mean velocity and prevailing direction for each month and the year, whether the high winds are moist or dry, and whether the prevailing winds are continental or oceanic; if continental, whether they come as warming and

so drying winds from over some mountain range, and if oceanic, whether they will not produce too much fog and too chilling conditions at certain seasons of the year. Experiments show that a wind blowing at the rate of ten miles an hour, other things being equal, causes almost four times as great evaporation as during calm weather, while blowing thirty miles an hour there is over six times the evaporation. Hence it is not hard to find the cause for the aridity of some of our western plains or even the upland farms of our own district.

Generally speaking, the climate of any place may be put under one of three heads: continental, insular and mountain. If one be given the latitude and the general surroundings of any place, its climate and weather may be easily written in general terms, and, further, the characteristics and leading occupation of the inhabitants can be determined. We must know the general arrangements of the great air and ocean currents to determine this, and also the intensity and average path of movement of the local atmospheric disturbances.

The heat from the sun is the cause of all the air movements, as well as the source of all life and power on the earth. The air warms fastest in the equatorial regions, and, expanding as it warms, it is forced up by the denser, cooler air on either side. The ascending current cools and flows out toward the poles, and, cooling more, settles to the earth again, part flowing back toward the equator and part moving on as a surface wind toward the poles. Then, generally speaking, the great air currents are well marked, but they are varied and magnified by the topography and by the different seasons. There is an area of nearly calm but ascending air around the earth near the equator, called the doldrums. Another area, narrower and less apt to be entirely calm for any length of time, are the so-called horse latitudes, near the tropics. Between these two belts and flowing toward the equator, from the north-east in the northern and the south-east in the southern hemisphere, because of the revolution of the earth, we have the trade winds. Outside of the tropics are the prevailing westerlies, which move toward the poles; but because the winds are passing from a section of the earth's surface which has a rapid mo-

tion toward the east in the revolution of the earth, toward the axis of the earth which has no motion, they are carried ahead and come to us in the northern hemisphere as west-south-westerly winds, and in the southern hemisphere from the west-north-west. In these general air currents local eddies or waves of higher and lower barometric pressure, called respectively anticyclones and cyclones, are formed and move along with the general current, influencing the winds locally.

If the local disturbance be a cyclone, the air at the centre has become warmed, and, expanding, has been forced up by the denser air from all sides, which, expanding in turn and flowing up, gives place to other air, till there is a general inflow from all sides; not blowing directly toward the common centre, but, because of the revolution of the earth, moving spirally around the centre in a direction opposite to the movement of the hands of a watch in this hemisphere and with the hands in the southern hemisphere. This area will move along at the rate of one hundred to five hundred or more miles in twenty-four hours, giving altogether different winds and weather in different parts of its area, which may cover a section several hundred miles in diameter.

The approach of one of these storm areas is often noted first by a veil of very high and fine clouds, which cause sun and moon halos, the clouds thicken and appear lower, and the wind, which at first was very light and from the east, begins to increase perceptibly in velocity. The clouds soon obscure the sun or moon, and the rain or snow falls. If the centre of the disturbance passes to the north of us, the winds veer to the south-east, then to the south, south-west and to west and north-west as the centre passes, with the breaking up of the clouds and with squally conditions. If the centre moves to the south of the place of observation, the wind backs to the north-east, north and north-west, and if it be in winter, snow usually falls. Behind the storm area will come the anticyclone or wave of higher pressure, with the wind blowing out from the centre. These latter areas are due to the descending current of air, which has flowed up at the centre of some cyclone, and comes down to the earth again in the anticyclone area, but dry and clean,

having been freed from its moisture and impurities in the upper air. The anticyclone is often ushered in with high north-west winds, and if in winter, a sharp cold wave. Then the wind decreases, and as the centre of the area spreads over a district the temperature at night is carried very low because of the free radiation of heat. It is under these conditions that marked inversions of temperature occur, and one riding across the country at night will find the cold much more intense in the valleys than upon the hill-sides. It is in the clear, still air that frosts are to be feared in the spring and fall, instead of in the windy front of the anticyclone.

The cyclonic areas in the United States move in three general paths. One class form in the north-west and pass down over the Lakes and the St. Lawrence valley; the second class form somewhere along the eastern slope of the Rockies, or else move over the mountains, and, passing farther to the south, move off the coast to the south of our district; while the third class come from the south and pass along the coast to the east of us, or else move across our district from south to north. The much-dreaded West India hurricanes belong to the latter class, and much damage is often done by them. Of all the storms in the United States, fully 80 per cent pass along one of these paths, and of course give our district part of their weather conditions. And as these cyclones occur on an average of every three or four days, one can readily see why we have weather in such variation and quantity.

The alternately clear and cloudy skies, with frequent showers, except in rare instances of drought; the varied temperature, the equable distribution of precipitation through the months and year, — all conduce to the rapid and hardy growth of our crops. Our seasons are short, but the sun's rays come easily through the comparatively dry atmosphere, and crops grow quickly, and in the alternating warm and cool air they attain a closeness of grain not excelled elsewhere. The grains are bright and solid, the vegetables crisp and well formed as they can only be with rapid growth, and our fruit is unsurpassed in fine flavor and keeping qualities.

In considering the matter of weather or climate and crops,

it is being more and more realized that the conditions and texture of the soil in its ability to retain or rid itself of its moisture is the true influence on our crops, and that the actual amount of water contained in the soil determines the character of the season, instead of the amount of rainfall. In the light, sandy soils there is little resistance offered to the flow of water, and a falling rain runs through it quickly, and it is dried out rapidly by evaporation, etc. Such land is best adapted to truck farming, while the darker, clayey soil, offering greater resistance to the flow of water and so retaining more of its moisture, is best adapted for grass and grain crops.

The evaporation of moisture from the soil is an important consideration, and much more attention should be paid to it than is now done by the average farmer. We cannot protect our fields from the evaporating effects of the wind and sun, but we can greatly check and hinder it by a judicious use of the cultivator among our hoed crops. By frequent stirring of the surface of the ground we form a fine mulch, which prevents a rapid heating of the soil, and in a great measure the evaporation from the soil and subsoil. There are many interesting points that might be discussed in this connection, but thorough preparation of the land, with subsoiling where it is necessary to break up a compact subsoil, followed by shallow but frequent cultivation of the surface, will undoubtedly make our average crops much safer during our short but sharp summer droughts.

Plants may be grown in latitudes in which they are not indigenous, but the districts of best growth of all plants may be sharply defined climatologically. We know, for example, that the crops that make best growth in the southern United States would give no results if planted in New England, yet they will thrive and do well in the same latitude in western Europe. Grazing and agricultural pursuits are carried on to considerable extent in Norway and Sweden, while in the same latitude in this country there are vast deserts of ice and snow. In one case the shores are washed by the warm waters of the gulf stream, and warm southwesterly winds prevail; and in the other the cold arctic waters and the westerly, dry, cold, continental winds have the controlling influence.

Man, on the contrary, is a migratory animal, and can and does adapt himself to latitudes and climates of great differences. He becomes acclimated, but in the acclimatization he is "climatized," and his physical habits and actions become very much like those of a native. Those habits and characteristics are very different in different places and climates; but almost without exception, where the weather changes are few and moderate, there you will find the inhabitants naturally indolent, and devoid of that high degree of intelligence possessed by the people living under more changeable conditions. We may go to the hot and dry interiors of equatorial climes, to the wet and more temperate coast districts and sea-islands, or to the other extreme, the lands of ice and snow, and we find people very different in every respect from those dwelling in that part of the temperate zones where weather changes follow each other with marked frequency. The character of man seems in some indefinable way to be benefited and strengthened, and his whole being built up and vitalized, by frequent weather changes. Where do we find the live, able and energetic man, — the man whose every faculty is developed to the full extent, who is broad and clear-minded, open and honest-hearted, but in the parts of the temperate zones where weather changes are most frequent? Where do we find those characteristics of man more marked than in old New England, where the beauties and grandeur of nature are best exemplified, where the changes in weather, more frequent and variable than in any other section of the earth almost, serve to keep one constantly on the alert, as it were? It is here that pluck, perseverance, activity and honesty have been the inheritance since the days of our forefathers.

The lecture was illustrated by the stereopticon. Views of some of the stations of the Weather Bureau were shown, together with the principal instruments used at weather bureau offices. Weather maps, showing characteristic weather conditions, such as circulation of the wind, the influence of wind on the temperature, the area of rainfall, were illustrated, and the different classes of cyclones were described in detail. Photographs of lightning flashes, dif-

ferent kinds of clouds, tornado effects and miscellaneous phenomena were exhibited and explained.

A sample of the weather map or chart referred to above is included with the lecture, and the following explanation of the map is issued by Prof. Willis L. Moore, chief of the United States Weather Bureau, and is here appended: —

The weather map presents an outline map of the United States and Canada, showing the stations where weather observations are taken daily at eight A.M. and eight P.M., seventy-fifth meridian time, and telegraphed to Washington and other cities. These observations consist of readings of the barometer, thermometer (dry and wet), direction and velocity of wind, state of sky (whether cloudy or otherwise) and amount of rain or snow. Solid lines, called isobars, are drawn through points having the same pressure, a separate line being drawn for each difference of one-tenth of an inch in the height of the barometer. Dotted lines, called isotherms, connecting places having the same temperature, are drawn for each ten degrees of the thermometer. Heavy dotted lines, inclosing areas where a great change in temperature has occurred within the last twenty-four hours, are sometimes added. The direction of the wind is indicated by an arrow flying with the wind, or opposite to the ordinary vane, and has a square end when storm signals are displayed. Shaded areas show where rain or snow has been falling since the last observation.

The general movement of storms in the United States is from west to east, similar to a series of atmospheric waves, of which the crests are designated on the map "highs," and the troughs or depressions "lows." These alternating highs and lows have an average easterly movement of about six hundred miles per day.

High winds, with rain, or snow if cold enough, usually precede the low area, often extending to a distance of six hundred miles to the eastward of the centre of the storm. In advance of the low centre the winds are generally southerly, and consequently bring high temperature. When the centre passes to the east of a place the wind at once shifts to the west or north-west, bringing lower temperature. The temperature on a given parallel west of the low may be reasonably looked for on the same parallel to the east when the low has passed, and frost will occur along the north of an isotherm of about forty degrees, if the night is clear and there be but little wind. Following the low usually comes an area of high, bringing sunshiny weather, which in its turn is followed by another low.

By bearing in mind a few general rules as to the direction and

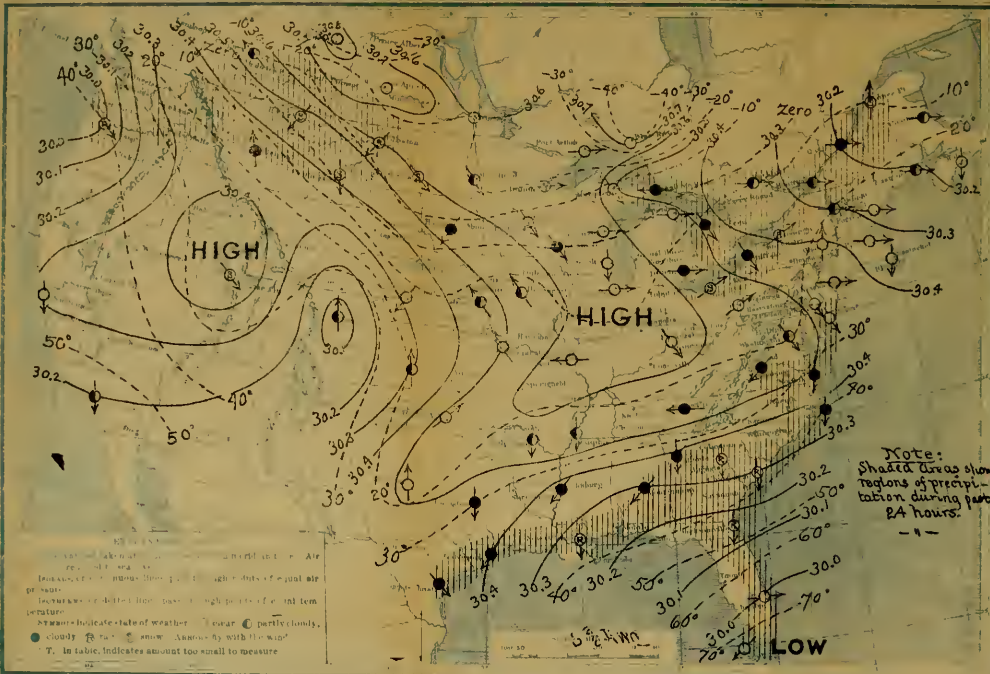
U. S. Department of Agriculture.

WEATHER MAP.

Published by authority of Secretary of Agriculture.

WILLIS L. MOORE, Chief of Weather Bureau.

Form 111



For Boston and Vicinity: Fair to-night and Wednesday; colder to-night; west to northwest winds.

U. S. Department of Agriculture

Weather Bureau

POST OFFICE BUILDING. TELEPHONE 491, BOSTON.

Boston, Mass., TUESDAY, DECEMBER 1, 1896.

FORECAST FOR NEW ENGLAND.

Generally fair to-night and Wednesday; colder to-night; northwest winds.

WEATHER CONDITIONS

Snow is falling in the Northwest and eastern Lakes, and rain in parts of the Gulf States; elsewhere the weather is fair. Rain or snow fell during the day past in the Gulf and South Atlantic States, Lake Region and St. Lawrence Valley, and the Northwest.

The barometer remains high in all districts but is falling off the southern coast of Florida.

The temperature is low in all parts of the country; it has fallen in most sections east of the Mississippi River, but it is warmer west of it.

J. W. SMITH,

Local Forecast Official.

Observations taken at 8 A. M., 75th meridian time.

Districts and Stations.	Barometer readings, in inches.	Temperature. Of air, degrees Fahrenheit.	Change in 24 hours.	Sensible (wet therm.).	Minimum in past 24 hours.	Wind velocity, in miles per hour.	Rainfall in past 24 hours, inches.
Atlantic Coast.							
St. Johns	......	......	......	......	......	..	......
Sydney	30.12	26	−2	−24	−24	Lt	0
Father Point	30.14	10	0	10	4	6	.02
Chatham	30.18	10	−6	10	10	Lt	0
Halifax	30.18	24	−4	24	22	10	Lt
Quebec	30.20	14	−4	12	12	12	0
Montreal	30.28	18	−6	16	18	12	04
Eastport	30.20	24	−4	22	24	8	0
Northfield	30.30	20	−2	16	10	16	08
Portland	30.20	22	−8	20	22	6	0
BOSTON	30.34	24	−6	22	24	12	0
Nantucket	30.32	28	−10	24	28	10	20
Albany	30.40	24	−4	22	20	Lt	0
New York	30.44	24	−6	22	22	12	0
Sandy Hook	......	......	......	......	......	18	
Philadelphia	30.42	26	−4	24	24	6	0
Atlantic City	30.44	22	−2	22	22	12	40
Washington	30.54	15	−12	10	8	Lt	0
Lynchburg	30.52	26	−6	24	24	Lt	.01
Norfolk	30.48	34	−6	30	32	10	.64
Hatteras	30.32	44	−6	42	40	36	08
Charleston	30.30	36	−10	34	34	18	34
Augusta	30.34	34	−8	30	34	14	62
Jacksonville	30.12	48	−16	46	44	12	.28
Jupiter	30.00	68	−6	68	66	Lt	24
Key West	29.98	76	0	70	70	Lt	42
Gulf States.							
Atlanta	30.38	32	−2	30	30	6	.04
Montgomery	30.30	36	+4	32	34	12	06
Vicksburg	30.30	34	+6	32	32	8	0
New Orleans	30.24	34	−2	34	32	14	36
Little Rock	30.54	22	+2	18	22	10	0
Palestine	30.46	30	−2	26	30	8	0
Galveston	30.40	36	−2	32	36	16	06
Corpus Christi	30.46	36	+4	32	30	12	12
Ohio Val. & Tenn.							
Memphis	30.56	22	+2	18	20	8	0
Knoxville	30.54	24	−2	22	22	10	0
Cincinnati	30.68	16	0	14	14	Lt	0
Pittsburg	30.56	16	−4	14	16	8	0
Lake Region.							
Rockliffe	30.36	−2	−20	......	−2	6	04
White River	30.74	−11	−38	......	......	0	0
Port Arthur	30.62	−8	−4	−22	−24	Lt	0
Parry Sound	30.36	10	−12	10	8	6	1.20
[illegible]	30.40	16	6	16	14	28	12
Lake Reg.—Con.							
Oswego	30.36	18	−4	18	18	12	50
Rochester	30.40	16	......	14	14	14	08
Buffalo	30.48	16	−6	15	14	15	T
Erie	30.48	18	−8	18	18	12	30
Cleveland	30.52	14	−4	12	14	16	T.
Detroit	30.56	14	−6	12	12	12	T.
Alpena	30.50	6	−8	4	6	6	T.
Sault Ste. Marie	30.48	−2	−16	−4	−2	6	.04
Marquette	30.50	−6	−4	−6	−6	14	T
Green Bay	30.64	−4	−4	−4	−4	8	0
Milwaukee	30.64	4	+2	4	4	Lt.	0
Chicago	30.66	8	+2	6	8	10	0
Duluth	30.66	−20	−2	−20	−20	8	0
Upper Miss. Val.							
St. Paul	30.66	−8	0	−8	−8	Lt	0
La Crosse	30.64	0	+4	0	−4	Lt	0
St. Louis	30.66	16	+4	14	12	6	0
Missouri Val.							
Kansas City	30.50	18	+12	16	4	6	0
Omaha	30.46	16	+18	14	14	Lt.	0
Huron	30.58	−2	+12	−2	−16	6	0
Moorhead	30.16	−26	−4	−26	−26	8	0
Bismarck	30.66	−16	+6	−16	−20	Lt	T
Williston	30.60	−12	+6	−12	−24	Lt	.04
Northwest Ter.							
Winnipeg	30.60	−30	−6	−30	−32	0	0
Minnedosa	30.70	−24	......	−24	−24	0	0
Qu'Appelle	30.72	−24	+2	−24	−26	0	0
Swift Current	30.72	−18	−8	−18	−20	0	0
Medicine Hat	30.66	−8	+4	−10	−24	0	0
Battleford	30.82	−38	0	−35	−38	0	0
Prince Albert	30.56	−32	......	−30	−40	0	0
Edmonton	30.68	−26	......	−26	−26	Lt	0
Calgary	30.58	−10	−2	......	−14	Lt	00
Rocky Mt. Slopes.							
Havre	30.46	−6	+12	−6	−10	6	.14
Helena	30.32	14	+22	12	−8	Lt.	.04
Miles City	30.44	−2	+14	−2	−18	10	06
Salt Lake City	30.46	24	+20	24	4	8	T.
North Platte	30.36	10	+12	8	10	8	0
Denver	30.10	38	+32	30	26	12	0
Dodge City	30.30	20	+8	20	20	6	0
Amarillo	......	......	......	......	......	......	......
Oklahoma	30.52	18	+4	16	18	6	0
Abilene	30.56	16	−8	16	16	8	0

rate of movement of the low and high, with the blowing of the wind from the high toward the low, coming weather changes may be foreseen by a glance at the map. The centres of low do not, as a rule, move across isotherms, but follow their general direction. Areas of low pressure frequently move to the south of east from the Rocky Mountains to the Mississippi, and then change direction to the north of east over the eastern half of the country. Storms in the Gulf of Mexico occasionally move to the west or north of west, but after reaching the coast they generally change direction and move to the north-eastward. High areas move to the south-east, and are attended by fair and cold weather. A cold wave is always accompanied by a high.

The cloud and rain area in front of a low is generally about the size of the latter, and oval, with the west side touching the centre of the low in advance of which it progresses.

When the isotherms run nearly east and west no decided change in temperature will occur. If the isotherms directly west of a place incline from north-west to south-east, it will be warmer; if from north-east to south-west, it will be colder. Southerly winds prevail west of a nearly north and south line cutting the middle of a high, also east of a like line cutting the middle of a low. Northerly winds occur west of a nearly north and south line passing through the middle of a low and also east of a similar one through the middle of a high.

An absence of decided waves of high or troughs of low pressure indicates a continuance of existing weather which will last till later maps show a change, usually first appearing in the west.

The sensible temperature published in the table with the map is the reading of the wet thermometer (a thermometer the bulb of which is always kept moistened), and represents the temperature which is felt at the surface of the body, especially where the skin is exposed, as on the face and hands. When the air is dry, this temperature, owing to the rapid evaporation of moisture, is considerably lower than the actual temperature of the air.

Evening Session.

The evening lecture was given by Hon. William E. Simonds of Hartford, Conn. The subject was "Man the creator; the development of inventions." The lecture was listened to with rapt attention by a large and appreciative audience, and was exceedingly instructive and entertaining. It was beautifully illustrated by the stereopticon. By agreement the lecture is withheld from publication.

SECOND DAY.

The meeting was called to order soon after ten o'clock by Hon. J. S. Grinnell, first vice-president, who introduced Mr. Francis H. Appleton, second vice-president, as the presiding officer for the day.

Mr. Appleton. I recall recent conversations with farmers of the West. Their talk was of the great depth of their most fertile soil. We of the East have a shallow soil of scant fertility, but on that soil has grown up a people of whom the whole nation may be proud. Our experiment stations are teaching us how to make this infertile soil produce abundant crops. Of these stations the New York State station is one of the most successful. Its director has consented to address us at this time on "Commercial plant food." I have the pleasure of introducing Prof. W. H. Jordan of Geneva, N. Y.

Professor Jordan. I have come to you this morning to discuss some of the general relations of the fertilizer trade, rather than questions pertaining to the use of fertilizers. I have come with a written statement of what I wish to present, which is somewhat contrary to my usual custom, and it is only because the secretaries of these boards of agriculture must have something with which to fill their volumes, even if it is not so good, that I took the trouble to write what I have to say. When I am in my own State, the State in which I work, I talk to the people without the manuscript.

Commercial Plant Food.

BY PROF. W. H. JORDAN, GENEVA, N. Y.

The American farmer is complaining of hard times. He declares that the prices at which he is now able to sell his products return to him no profits, or at least those which are inadequate for supporting him and his family in a desirable manner. The experiences of the recent election show also that the agriculturist is inclined to attribute his lack of prosperity to causes which lie largely outside of his own direction. Moreover, he appears to be convinced that he can remedy the unfortunate conditions which surround him through legislation affecting either the tariff or the financial methods of the country; and, in cherishing the false delusion that legislation is the chief factor in determining business conditions, he forgets to carefully analyze those other factors of success which are under his own control. While he certainly is rash who declares that he is able to point out all of the complex causes which affect the farmer's business, and while we must confess that some of these are social rather than individual, a large and important part relates to the methods and activities which prevail on the farm.

This important fact should be considered in connection with another; viz., that there is little likelihood of our returning to the prices for agricultural products which during the last half-century have been regarded by the producers of grain, meat and dairy products as satisfactory; and in expressing this view I am in accord with many who have given this matter careful consideration. It seems almost certain that the farmer must in the future adapt himself somehow to a much lower scale of prices than has ruled since the close of the war. While we do not expect that

pork will always sell at three cents a pound, or cheese at six and one-half cents, as has been the case in New York during a portion of the past year, there is little prospect of a return to the prices which have been regarded as mortgage lifters. If this prophecy proves true, nothing remains to the American farmer but to adjust his business to the new conditions. He must carefully scrutinize his methods and determine where expenditures may be reduced, and in some way lower the cost of production.

In such a study of his business there are very many things for the farmer to consider, prominent among which is the matter of plant food. Here is a problem of fundamental importance. Crop production imperatively demands raw materials, which we call plant food, and which must be secured from some source or other. Until within the last half-century the farm was the exclusive source. With the exception of market gardeners, in close proximity to cities and large villages, every farmer depended upon his soil and the atmosphere to furnish him with the necessary materials out of which to build plants. The words nitrogen, phosphoric acid and potash, as used in a commercial sense, were not in his vocabulary; in fact, very few farmers realized any of the great truths concerning plant nutrition which are now so generally understood. But all this has been changed. Theories of plant nutrition are abroad. Plant food is in the market. The farmer purchases raw material for his business, just as does the manufacturer of shoes or of any other commodity.

The commercial fertilizer trade has become one of the important ones in this country. It reaches out in all directions. It has caused the utilization of vast quantities of refuse materials which otherwise would have been thrown away. It has moved the prospector to carefully and persistently search for mineral deposits which otherwise would have been ignored; and because of the demands made by this trade, we have imported vast quantities of materials from subterranean deposits which exist across the water.

The miner, the chemist, the engineer, have all been enlisted in this tremendous effort to transform the contents of nature's great storehouses into mixtures that make possible

more corn, more wheat, more human food. This may properly be regarded as a triumph of economic science, for it powerfully increases the capacity of all civilized countries to sustain the vast populations that are sure to exist.

A few years ago Hon. Carroll D. Wright, United States commissioner of labor, was directed to ascertain the extent of the fertilizer trade in the United States; and he reported that in the year 1892 one and one-half million tons of manufactured goods were sold in the United States at a cost to the farmers of fifty-three million dollars. It does not appear to be an exaggerated estimate to declare that in 1896 this quantity had probably reached two million tons, at a cost of not less than sixty million dollars. This is a vast sum of money, which is paid, we must remember, from the proceeds of our farms. Moreover, it is a cash expenditure, to meet which there must be actual sales of farm produce, — a fact of no little significance.

It is important to remember also that this fertilizing material is used chiefly in the eastern half of our country. So far, the great west has depended upon stores of plant food which have so long awaited the use of man. Not so with the eastern farmer. Many of our crop producers, even some who are growing ordinary field crops, depend very largely for a supply of plant food upon commercial fertilizers. The most remarkable instance of this which I am able to cite is the case of the Aroostook County potato growers. Here is a new country, the natural resources of which are by no means exhausted, being perhaps one of the most fertile spots in New England, into which commercial nitrogen, phosphoric acid and potash have been imported to the value of many thousands of dollars annually. Notwithstanding the fact that the Aroostook County farmer has had around him vast stores of the needed elements of fertility, he has preferred to spend cash for his raw materials, rather than attempt to find some means of making useful the materials already within reach. He has been warned of a day of judgment, and already there are clouds in the horizon considerably larger than a man's hand, which are a forecast of impending danger.

The proper consideration of our subject in its practical

relations demands that we should inquire as to the causes of this rapid development of the commercial fertilizer trade. The first cause, and the one which most naturally comes to our minds, is the exhaustion of the soil. There is no question but what the pioneer farmers were spendthrifts. Nature was kind to them, in that she furnished them abundantly with materials for crop growing; and, as largely through ignorance and partly through indifference one generation is prone to ignore the needs of the next, so our fathers wasted the heritage of the sons. Those who cultivated the virgin soil drew heavily upon these new lands, without making adequate return. In this way, all over the eastern States much of our farming lands had come into such a condition, through ignorant, careless and indifferent methods, that profitable crops could not be grown without unusual preparation. When commercial fertilizers came upon the market, and farmers began to see that by the application to the soil of a few hundred pounds of some particular material they could secure an increase of crop to the point of profit, many immediately turned to this new ally of modern agriculture as a means of doing a profitable business. Doubtless some halted between two opinions; but example and precept have done their perfect work, and now the old-fashioned farmer who depends upon the barnyard is the exception, not the rule.

And there is no question but what the commercial fertilizers have been used at a profit by a large number of farmers, especially during the reign of what we now regard as high prices. Whether this shall continue to be true under the changed conditions to which we have referred, depends, we believe, very much upon the farmer's method of management.

I trust I shall not be misjudged, if I state, moreover, that commercial fertilizers are a favorite adjunct to what may be styled lazy farming. The men whose methods have involved good cultivation and careful attention to every detail which relates to the maintenance of fertility, know that the conservation and development of the home resources involve a great deal of labor. It is only the active, thoughtful, industrious man who can take a farm,

however fertile it may be at the beginning, and maintain it in a satisfactory condition without aid from outside sources. The use of commercial plant food involves less difficulties, at least to the sluggish. The farmer simply takes a trip with his farm cart to the nearest village some pleasant spring morning, carrying with him in many instances a promise to pay for the goods when the crop is harvested, and returning with the plant food he might have saved, possibly. This very convenience and ease of obtaining the raw materials for crop production has, I am sure, caused a larger sale of commercial fertilizers than would have otherwise been the case. We believe it is a proposition that is true and somewhat generally applicable to the older sections of the country, that, because farmers have been able so easily to supplement their supply of plant food by the purchase of commercial fertilizers, there has been a tendency to ignore home resources; and consequently the methods of practice which are calculated to save and increase the home supply of plant food have not developed, as would have been the case had stern necessity required.

This is an explanation of the rapid increase of the sale of commercial fertilizers from the farmer's side. The manufacturer is, however, partly responsible for it, and naturally so. He has been for very obvious reasons a persistent, extensive and in some respects an unscrupulous advertiser. He has sent agents, who as a rule have been shrewd advocates, into every hamlet of New England; and nearly every prominent farmer of our best agricultural regions has been made the subject of a personal appeal to at least make an experimental trial of some brand of fertilizer. The printing press has been freely used, and through our agricultural papers and by means of special pamphlets and advertising placards the farmer has not only actually been helped in his understanding of plant nutrition, but has been informed of the extraordinary results that come from using commercial fertilizers, has been told of the way in which they have enlarged his neighbors' profits, and has been shown that his only salvation was to be found in their use. No soap or baking-powder manufacturer has been more active or ingen-

ious in his methods of disposing of his wares than has the manufacturer of superphosphates. As a result, the use of commercial fertilizers has become widely distributed, and from year to year has rapidly increased. Am I not warranted in declaring that in this way the fertilizer trade has been stimulated in the country into unnatural proportions, — that is, into proportions inconsistent with the possible home supply of plant food and with the ability of the farmer to buy judiciously and use wisely superphosphates at thirty to forty dollars per ton?

It is but fair to say, however, that a great majority of the farmers must have become convinced that commercial plant food was a source of profit to them, otherwise its use would have diminished, instead of increased. We are not disposed to question the fact that profit has thus accrued, with the prices which have in the past prevailed, even if the methods of buying have been of the loosest and most irrational kind. Shall we continue to do as we have done? is the question to which we now address ourselves.

In order to properly consider the relations in which the farmer stands to the commercial fertilizer trade, and the changes which we believe should occur in the methods that now prevail, it is necessary to consider the prominent and in some respects unique features of this trade.

We remark, first, that it is the only trade that is under close chemical control in nearly every State of the Union where such a trade exists, except possibly the sale of milk. In all of our eastern and middle States there exist laws for the inspection of commercial fertilizers; and in every such State it is the duty of the experiment station or some official organization to see that the provisions of this law are properly executed. Manufacturers of fertilizers often complain that it is unfair to select them as the objects of such close scrutiny, and allow dealers in other commodities to take their chances with the public, without any trammel whatever. Undoubtedly there is some force in this objection. There is no question but that foods, drugs, seeds and other commercial articles are fraudulent and deceptive to an extent which calls for legal supervision. This would

now be true of the fertilizer trade to an unheard-of degree, had it not been placed under close scrutiny. We know of no commodity, involving an equal expenditure of money, where it is so easy to deceive the purchaser and so difficult for the purchaser, through the use of the thing bought, to determine whether or not he has been defrauded, as is the case in the fertilizer trade. Whatever may be needed in other directions in the way of official supervision of trade, it is now generally conceded by the more intelligent and agricultural public and by the great majority of fertilizer manufacturers that official inspection is beneficial to both parties.

A forcible illustration of the value of such close supervision of the fertilizer trade has come to my attention in New York, where a material advertised as "natural plant food" has been forced upon the attention of our farmers. We found samples of it in the market, and after the farmers who had bought it discovered that it failed to increase the crop returns as they had a right to expect from the advertised statements, they began to appeal to us for information. Our investigations made it plain that the mixture was chiefly Florida soft phosphate, combined with a small proportion of a potash mineral known as glauconite, — materials of some value when used judiciously, but worth greatly less commercially than the price at which the fertilizer was selling. We regarded the matter of sufficient importance to be made the subject of a bulletin, and hope we have checked the sale of this fertilizer at the price asked.

Not only is the fertilizer trade under control in most States, but these laws differ widely in their provisions and requirements. Some States require no license, some collect an analysis fee on each brand, some exact a tax on the business as a whole and some assess a tonnage tax.

The required markings on the bags are unlike in the several States also, as well as the written guarantees which must be deposited in the office of the inspector. There are other differences, which, together with those mentioned, constitute an annoyance and expense to even the best disposed dealer. I do not blame these business

men for asking for uniform legislation relating to fertilizer control.

Again, the chemical side of the fertilizer control has certain unfortunate weaknesses. In some particulars the chemist's determinations are all that could be desired, but in other directions he is subject to limitations which no one regrets more than himself. It is now entirely possible to accurately find out the total amount of nitrogen in a fertilizer, but no method has been discovered, such as the careful official is willing to make the basis of published statements, by which to identify the low grades of organic nitrogen. Let us hope that some method of this kind will be forthcoming.

I am free to confess, also, that the chemist is somewhat lame in his estimation of the amount of available phosphoric acid, if we use the term "available" as meaning that which can be directly appropriated by plants. We have in the market compounds of phosphoric acid that are counted as available by the chemical methods now in vogue, which are probably used to reinforce the percentage of the so-called available phosphoric acid in mixed goods, but which give in actual practice no certain promise of greater value than we know crude South Carolina rock possesses. I refer to certain dehydrated phosphates of iron and aluminum that have found their way into the fertilizer trade within a comparatively recent time, but which appear in the experience so far reached to compare very unfavorably with soluble phosphoric acid as food for such crops as potatoes, corn and other grains. We cannot now reasonably claim that we are able to find out by artificial means just what compounds of phosphoric acid the plant can promptly feed upon, excepting, of course, those which are soluble in water previous to their application to the soil.

The fertilizer dealer has had the unique experience of having his goods made the subject of comparative money valuations. Some official chemists have undertaken to state the cash sum at which the ingredients of particular fertilizers could be bought after deducting certain expenses. No State law has required this, but it has been done for the purpose of rendering more useful the results

reached by the chemical analyses. When fertilizer control was first inaugurated in this country, a table showing the composition of a superphosphate would have been meaningless to most farmers, and it was felt necessary to present some simple standard, even though an imperfect one, by which the various brands of goods could be judged. This was wise. Such money valuations have been a most efficient means of pointing out cases of extortion and overcharge.

The fertilizer manufacturer has never ceased, however, to rebel at these station valuations. He has declared that they are unfair, because they take no account of the quality of the nitrogen ; and are misleading to the farmer, because he erroneously assumes the agricultural value to be proportional to the station valuation.

These are some of the much-discussed and troublesome points involved in fertilizer control, the further consideration of which I will resume a little later.

A second noteworthy feature of the fertilizer trade is the manner of advertising, which prevails to a large and unfortunate extent.

In commenting upon this, I hasten to acknowledge, first of all, that the ethics of advertising are past finding out. All intelligent and discriminating persons have long ago given up taking at their face value the advertisements of the merits of various wares. We have come to expect tricks of the imagination and distortion of facts, and so by common consent we pass mild judgment upon the person or corporation who "bears false witness" in the advertising columns of our weekly paper. Why we do this is not evident, unless for the reason that familiarity with sin has hardened our hearts. We do not mention the fertilizer manufacturer in this connection because he is worse than his neighbor, but because in so many instances he is no better. He is not dealing with a nostrum, or at least he should not be, but with one of the great economic facts of human living. His stock in trade consists of materials as essential to the continuance and welfare of the human family as are food and clothing, — in fact, consists of materials that are fundamental to the production of food

and clothing. He is handling those things which touch the well-being of a nation, those things which should be dealt with by businesslike and well-ordered methods. Let the patent medicine dealer go his own way, with his miraculous and impossible cures; but let those engaged in a worthier and more useful calling discard distortion and all highly colored ways of calling public attention to their goods, and take their place alongside other men who are trading in staple commodities. Only in this way will the retail fertilizer trade everywhere regain and maintain the standing which rightfully belongs to it.

The trade names of mixed fertilizers should claim a share of our attention, and very properly in this connection, because these names are involved in the advertising methods which we have discussed. Let me give you a few illustrations, taken from Bulletin No. 107 of the New York Agricultural Experiment Station: "Pointer Brand," "Farmer's New Method," "Hustler," "Defiance," "King Philip," "Gold Brand," "Matchless," "Composition," "Phœnix," "Reaper," "Great Eastern," "Success," "Dragon's Tooth," "Cyclone," "Pride of America," "Domestic," "Golden Sheaf," "Great Value," "High Farming," "Farmer's Benefit," "Pioneer," and numerous others equally ridiculous. But, you say, "Why meddle with these names? That's the business of the manufacturer, and if he is satisfied, why should we complain?" We protest against such names of the quack order, not so much because they hurt the manufacturer, as because they injure the trade by placing it in a false light. They bring it to the level of the traffic in nostrums. Every farmer instinctively recognizes the fact that they are the result of an attempt to attract his attention and his cash by high-sounding words that hint of wonderful results which are not to be realized. He quickly notes the counterfeit ring of insincerity and exaggeration that belongs to all such efforts to win his confidence, and he is therefore prone to conclude that he is dealing with parties the truth of whose statements may need verifying.

Fertilizer manufacturers often complain that they are unjustly accused of planning to defraud the public, and assert that their business is as honorably conducted as

others, — all of which is undoubtedly true. They must remember, however, that there is something in names, and, if their fertilizers bear those which smack of charlatanism and fraud, they must not complain if their business gets a corresponding flavor. To be sure, somewhat similar names are attached to the various brands of flour; but has not the public come to declare that these differ only in the brand mark, and that the barrels are all filled from the same source! I have no sympathy for or patience with such an imitation of quack methods in matters which mean so much to the agriculture of our country; and I believe the manufacturers would advance their own interests, as well as those of the farmers, if they would concertedly purge their business of everything but appropriate and sensible names.

Again, there are many brands of fertilizers bearing names which are not objectionable in themselves, but which are misleading. I refer to the so-called corn fertilizers, potato fertilizers, vegetable fertilizers. The fair inference is, that, if a mixture is named potato fertilizer, it is specially adapted to potatoes, and would be less useful in growing corn, but that for the latter crop a corn fertilizer should be purchased. Alas for the inference! Practice has very largely lost its faith in the significance of these names which imply special uses. Observing farmers now freely remark that they cannot discover the specific effect which is claimed; and why should we expect them to? While I would discard a fertilizer containing potassium chloride if I were growing tobacco, and would avoid an excess of nitrogen if I were a sugar-beet grower, and in a limited number of other cases would have regard for certain facts of universal application, observation forces me to the conclusion that the discovery of a mixture which everywhere shall be the best and most economical fertilizer for a certain crop is an utter impossibility.

If the plant were the only factor to consider, then one might compound a food to suit its needs; but when the largest factor of all in the problem is the soil, a factor which experience shows to be extremely variable, how absurd is the attempt to declare to the potato growers of an entire

State that this or that fertilizer contains just the proportions of nitrogen, phosphoric acid and potash which they should all use. This absurdity is heightened by the fact that scarcely any two companies agree in their discoveries as to what are the needs of the various crops. Even the same company advertises both a potato phosphate and a potato manure, which are not alike, but just why we certainly cannot affirm.

We have suspected — and, if this is unjust, we hope to be pardoned — that this multiplication of names is not due to any knowledge which warrants such differentiation of function with various fertilizing mixtures, but is simply a trade expedient, adopted with the hope of selling more goods under ten names than would be possible under one or two. And these business concerns have an undoubted legal and moral right to sell their wares under as many trade-marks as they please; but they are exercising this right in a way that is adding confusion to confusion, is increasing the expense and difficulties of the fertilizer control and is delaying the day of reason in the sale and use of plant food.

The next matter to which I shall call your attention is one touching the buyer, rather than the seller. We found at the New York Agricultural Experiment Station that the average composition of 313 brands of fertilizers sold in New York in the spring of 1896 was approximately 3 per cent N, 11 per cent P_2O_5 and 5 per cent K_2O. Why do these relations exist in the proportions of the three important elements of plant food as found in the New York trade? One manufacturer doing business in that State sells a potato fertilizer in which the nitrogen, phosphoric acid and potash are mixed in the proportions 1, 4 and 2½ respectively. In the case of another brand the proportions are 1, 2 and 3. What facts have been learned concerning the nutrition of the potato or the needs of New York soils that warrant either of these formulæ?

In some brands of goods sold in the famous potato-growing region, Aroostook County, Me., the ratio of nitrogen, phosphoric acid and potash is not far from 1, 5 and 3. What good and well-fortified explanation have

these potato growers to offer for buying potato nutrition in these proportions? Some leading Aroostook County farmers declare that the ratio is all wrong, and have contracted with the manufacturers for very different mixtures, in which, in a few cases at least, potash is the leading ingredient.

In general, why are manufacturers using the formulæ they do in supplying the general fertilizer trade? Are they imitating farm manures? Most certainly not, for in stable manure the phosphoric acid is less than the other two ingredients. Are they seeking to simulate the first of all commercial fertilizing mixtures, viz., Peruvian guano? If they are, they are not succeeding. Are they following the average composition of farm crops? Very far from it. Are they depending upon any well-defined data of acknowledged value in deciding what mixtures of plant food shall be offered to the agricultural public? We cannot learn that they are, except in a limited number of instances. We are all agreed that muriate of potash shall be kept out of tobacco fertilizers, that the seeding-down fertilizers may properly contain compounds of lower availability than those intended for use on hoed crops; but, beyond a few instances of this kind, we are unable to learn that the great bulk of the fertilizer trade is guided by a definite, intelligent demand on the part of the buyers.

In the absence of such a demand, what shall the manufacturer do? It is not likely that he will be controlled by the business conditions which chiefly influence his side of the transaction, such as the relative supply and cost of materials, methods of cheapening production, nature of the competition that must be met, etc. Many new firms are yearly entering upon the business of selling plant food, — men of good business ability, of undoubted integrity, who as a rule know nothing of plant nutrition, but who would be perfectly willing to supply farmers with what they want, provided they could find out what that is. Not having this information, they enter upon a plan which promises them the maximum profit, and which, for the farmer, is a most haphazard operation.

Allow me to say to you that, in my judgment, the fact

that we have applied to American soil during the last ten years plant food mixtures containing more than twice as much phosphoric acid as of either nitrogen or potash may be due in part to the immense supply of phosphatic deposits lying at our very door, in the handling of which there has been great opportunity for money making, and which have been pushed upon the market with great persistence and ingenuity. An investigation made during the past season by the New York Agricultural Experiment Station showed that when Long Island farmers used one ton of fertilizer to the acre, they used six times the phosphoric acid that the two succeeding crops removed, and that half as much of this ingredient was as efficient. It is a serious question whether the compounds of phosphoric acid have not been applied to our farms in excess. It is also possible that the great increase in the use of potash salts has not been caused wholly by a recognized need of more potash, but is to some extent due to the tireless efforts of the German potash syndicate to convince everybody that potash is an essential constituent of plants.

All that I have been saying on this point may be reduced to this single statement: the composition of the great bulk of the fertilizers sold in the country is dictated by the manufacturer, and not by the consumer. This is a reversal of the natural order. Can we attain to better things? Manufacturers are certainly not competent to guide the farmer in this important matter; for, notwithstanding their good intentions as business men, they as a rule, are not in a position, either by study or by other means of observation, to solve the difficult problems involved in the matter we are discussing. Is the farmer doing his best to aid the manufacturer in adopting a more rational basis for trade? Is the farmer doing his best for himself? To these questions I shall address myself later.

I suspect two comments have already been made in the minds of my hearers. The fertilizer manufacturer, if he is present, has said to himself, "This is the same old story. Experiment station workers, who cannot know the manufacturer's side as we do, are always attacking us, declaring that our goods are below the proper grade, and are sold at

an overcharge or by improper methods. We are having a hard time in attempting to accommodate ourselves to twenty or more different laws, affecting our business in as many States; dull times are upon us, and we cannot collect our bills; and it does seem as if we might be let alone."

On the other hand, the farmer is saying to himself, "Here is a fault-finder, an iconoclast who tells us that the fertilizer trade is all wrong, and brings us nothing to take the place of that which he condemns." I do not wonder at either comment. But I assure you, friends, that I am not wanting either in my sympathy for the trials which the seller of plant food has to endure, or in my appreciation of the complex and almost insoluble problems which confront the user in his attempt to purchase plant food economically.

I am confronted, however, with a fact of great moment, which is, that the fertilizer trade is not now conducted in this country in a manner that commends itself to the good sense and business judgment of those who are intelligently familiar with it in all its relations. It is an immense business, involving a yearly cash expenditure by the farmers nearly equal to a dollar for every man, woman and child in this great country. On many of our eastern farms the bill for fertilizers is one of the large items of expense, — an item which formerly did not exist, and which, in these times of small profits, should be closely scrutinized. From contact with farmers and from my experience as a fertilizer inspector during twelve or more years, I am convinced that the fertilizer trade can be vastly improved.

And now, after having frankly discussed some of the weaknesses and short-comings on both sides of the fertilizer trade, I ask you to turn with me from an attitude of criticism to a consideration of ways in which, in my judgment, greater economy may be secured in the buying and selling of plant food.

I shall present what I have to say under the following heads: —

(1) The relation of a State fertilizer control to the trade.

(2) Trade names.

(3) Special fertilizers.

(4) The farm side of buying plant food.
(5) The market side of buying plant food.
(6) Utilization of home resources.

Let us consider these divisions of our subject in the order named: —

(1) How shall the fertilizer control most efficiently aid both interested parties, — the manufacturer and the farmer? And I remark, first, that nobody is the gainer if a business is unnecessarily hampered by law. Any additional trouble and expense laid upon the manufacturer of a commodity is sure to react upon the consumer. It would be a great gain, therefore, if some uniform law, as simple in its provisions as would be consistent with its efficiency, could be adopted by all these States. This would make it easier for the dealer to promptly and correctly comply with the legal requirements, and would aid the State officials in organizing their work on a uniform and thoroughly efficient basis. That such unification of the legal control of fertilizers will be accomplished, seems too much to expect. We must wait for the millennium, I fear, before reaching such an ideal result.

In the second place, I observe that farmers should not attribute to the results of fertilizer inspection any unwarranted significance or value. The chief object of this inspection is to determine whether the manufacturer is selling goods that correspond to their guaranteed composition, and here the required duty of the official chemist ends. The tables he publishes in no sense constitute advice as to what fertilizer a particular farmer should purchase, nor is the column of money valuations, if such be given, a column of agricultural valuations, when considered with reference to a particular farm. All that the chemist affirms, or intends to affirm, is that a sample of John Doe's fertilizer, taken at Doetown, was found to contain such and such percentages of nitrogen, phosphoric acid and potash in such and such conditions. If the chemist states a money valuation, he only declares that the plant food in John Doe's goods is being sold in other materials for approximately a certain sum. If the fertilizer be rich in nitrogen, that sum is likely to be large; but if phosphoric acid preponderates, and only

small amounts of the other ingredients are present, then the necessary cost will be relatively low. The farmer may need the more costly material, — he may need the less costly. A decision of this question is the farmer's business alone, and he should emancipate himself from a dependence upon mere commercial standards as the only guide in his selection of a fertilizer mixture.

This brings us to a discussion of station money valuations. Some stations are publishing these, as, for instance, Connecticut and New Jersey, and some are not, among which are Maine, Massachusetts and New York. Which is the wise policy? It is evident that this is not a one-sided question, otherwise we would not see men of experience in this matter divided in their practice. In my own case, as executive of the fertilizer law in Maine, I published valuations for nearly ten years, and then stopped doing so. Why? Because I everywhere heard farmers discussing the merits of different brands of fertilizers upon the basis of the station valuations, and because, whenever a fertilizer company happened to secure higher valuations than some rival, this fact was spread far and wide, as a convincing reason for claiming superior merit. I said to myself, "This has gone far enough. Station valuations have had their uses, but the time has come for the farmer to take a step forward, and consider the kind and quality of plant food he is to buy; and it is time for manufacturers to show to the farmer some reason other than a higher money valuation why he should purchase a certain mixture." The important questions to ask are, "Who made this fertilizer? Has experience shown him to be reliable? What is he trying to sell me, — mostly phosphoric acid, or mostly potash, or largely nitrogen? Does he ask me to buy that which I need?"

I make these explanations as defining my own position, and with due deference to the opposite practice of such able men as Dr. Johnson and Professor Voorhees, who control the policy of experiment stations in other States.

(2) Perhaps enough has been said about trade names. It is well to clear away the atmosphere of quack nostrums such as clings to the names prevalent in the fertilizer trade.

The sooner the farmer comes to see that in buying plant food he is dealing with the same plain business facts that pertain to nails, brick, lumber, flour or any other staple commodity, the sooner will the fertilizer trade reach a substantial basis.

(3) I am sure, too, my friends, that the time has come to stop talking about corn fertilizers, potato fertilizers, wheat fertilizers, onion fertilizers and the like. The belief in such distinctions as now used in the trade is becoming obsolete. These names carry with them the inference that some person of great wisdom is preparing specifics for certain crops, both economical and efficient under all conditions. No greater fallacy than this was ever believed in. Even if these special mixtures corresponded to the actual needs of the crops, — and they certainly do not, — there is still to be considered the greatly unlike conditions prevailing on different farms, rendering a universal recipe illogical and wasteful. The forcing-house man may properly combine plant food in the proportions found in his tomato or lettuce crop, the tobacco grower may wisely exclude all chlorides from his artificial manures, the sugar-beet grower may find it necessary to avoid over-stimulation of the growing plants with nitrogen, but the only special for the individual farmer is the one that corresponds to his special needs.

(4) But right here I am met with the old question, — a difficult one, too, — "Can the farmer learn what his special needs are?" And this leads us to another division of our subject, viz., the farm side of buying plant food.

As we enter upon the discussion of this point, some one steps forward with his time-worn arguments, "Farmers don't know enough to determine their needs, and therefore we must put in their hands something that will be sure to cover all possible deficiencies, even if some do pay for unnecessary materials." Is this a fair argument? Are not a few farmers dictating their own mixtures of plant food, on the basis of careful study of their resources and intelligent experimenting to discover their needs? Shall we tell these men to stop doing this, because others do not, or shall we advise the others to do likewise? If only one person out

of five were capable of truth telling, should we exhort the one to lie, or attempt to reform the other four?

But can a farmer come to know from his own observations what are the elements of plant food of which he is most in need, or must he depend upon others to decide this matter for him? Years ago I was an assistant to Prof. W. O. Atwater at the time when he was conducting experiments in several States with various plant food mixtures, and I have not forgotten the striking facts developed by these few tests. On certain farms in the Connecticut valley the only ingredient which seemed to cause any material increase of crop was potash, while in Maine phosphoric acid exerted a predominating influence; and it was clearly evident that it would be unwise for the farmers of the two locations to purchase plant food in the same proportions. But you say that in these cases the farmers had expert help in discovering their needs, and without that aid they would not have succeeded so well. I am not so impressed with the impotence of farmers as some are. When they are convinced of the importance of any fact or principle in their practice, they have not shown utter inability to master it. As a matter of fact, a goodly number of crop producers have already taken intelligent direction of their plant-food supply, and the dealers are simply complying with their requests. Does a farmer wish to know whether he shall buy generously of potash, or not? Let him purchase a dissolved bone or an acid phosphate and an ammoniate, leaving out the potash, and carefully note the results. Is he a dairy farmer, who is buying large amounts of nitrogenous foods? Let him supplement his farm manures, if he must supplement them at all, with an acid phosphate, or an acid phosphate combined with a potash salt, and, in comparing the effect of this mixture with that of a superphosphate containing nitrogen, learn whether he can afford to further invest in this latter costly element. Is he a farmer who tills a limited garden area in the summer and a still more limited surface under glass in winter? Let him consider whether he should not take the special needs of his particular crops as a guide in his practice, and so use larger proportions of potash and nitrogen than the average super-

phosphate contains. I mention these cases as illustrations of the possible ways in which a farmer may come to exercise the same careful judgment in buying raw material for plant building that he would in purchasing nails, lumber and paint for constructing a house. There is nothing impossible or unreasonable in this suggestion. It is made in the interests of economy, and because of a desire to reform our haphazard methods of buying plant food to the extent of millions of dollars annually.

I would say to the farmer who wishes to rise to the higher plane of deliberately controlling his own plant-food supply, that there are two requisites for doing this. First, he must inform himself in regard to the composition of fertilizing materials, in order to know what to buy and how to make mixtures. Second, he must study his needs by the use of the unmixed, so called, raw materials. No crop grower will ever find out the special plant food deficiencies of his soil, if such exist, or the influence of certain ingredients upon the quality of his crops, by the use of the ordinary factory-mixed goods. He must at least dictate his own combinations, so as to know, for instance, whether the introduction of potash is profitable or otherwise.

(5) Granting, then, that a farmer may come to intelligently dictate his own plant-food supply, in what way shall he buy his nitrogen, phosphoric acid and potash? The answer to this question involves the market side of buying plant food. This is an old topic, somewhat threadbare, perhaps, but let me state some of the considerations which lead me to bring it forward.

In August of this year the New York Agricultural Experiment Station published the results of the analyses of 313 brands of fertilizers. We found, taking their average composition and average selling price, that the nitrogen was costing New York farmers 17.3 cents per pound, the available phosphoric acid 6.8 cents and the potash 6.2 cents. About the time that we had arrived at these figures, a shrewd farmer of Ontario County came into my office and asked for advice in mixing a fertilizer. He said: "I can buy acid phosphate guaranteed to carry 14 per cent available phosphoric acid at $12 per ton, and high-grade muriate

of potash at $40 per ton. Now, what shall I purchase for my nitrogen supply?" Before replying to him, I had calculated that his phosphoric acid would cost him only 4 cents per pound and his potash 4 cents, plus a small increase for freight. I said to him: "If you can get cotton-seed meal at $20 per ton, buy that. Allowing fair prices for the phosphoric acid and potash it contains, the nitrogen in it will cost you 12 cents per pound." I might have said, further, that at the prices he gave me for $19 he could mix a fertilizer similar to the average one sold in New York for $29, leaving him a margin of $10 to pay the freight from a not very distant point.

Not long since I was at Riverhead, on the eastern end of Long Island, and was informed that the farmer's club of that section had contracted with a manufacturer to make and deliver a mixture containing 4 per cent of nitrogen, 8 per cent available phosphoric acid and 10 per cent of potash, for either $26.50 or $27 per ton. This was at the rate approximately of 4½ cents per pound for phosphoric acid, the same for potash, and 13 cents for nitrogen. At the average rates ruling in the retail trade, the cost would have been not less than $36, or $10 more.

During the past few years the experiment stations of Connecticut and New Jersey have not ceased to advise the farmers of those States that it is economy for them to buy the unmixed raw materials, and make their own plant-food mixtures. Upon consulting the reports of these stations for 1895, I find the following facts: In Connecticut the stations analyzed 15 samples of home-mixed goods. Throwing out cases of special contract, it was found that in 11 instances the home mixtures cost, exclusive of mixing, only 90 cents per ton more than the station valuation. The mixing can be done at from $1 to $1.50 per ton. It appears that in the same year 151 factory-mixed brands, sold in the ordinary manner, cost an average of $34.80 per ton, which was $9.30 per ton more than the station valuation.

In New Jersey the station looked up the data of 9 cases of home mixing, and found that the cost to the farmers, after allowing for freight and mixing, was $3.06 per ton less than the station valuation of these mixtures. On the

other hand, 224 brands of factory-mixed goods cost on an average $8.72 per ton more than the station valuation, — a difference of 36 per cent.

Now, I do not bring these figures forward as an attempt to cast evil reproach upon those engaged in the retail fertilizer trade. I would not have you understand that I am suggesting fraud or overcharge on the part of the fertilizer dealers. I have no reason for supposing that honorable manufacturers or sellers of commercial fertilizers have been unduly prosperous. Certainly these business men have had their share of losses and failures. But these data which I bring to you are undeniable facts, nevertheless, — facts we cannot ignore, which mean something, and which deserve the careful consideration of every farmer who wishes to manage his business in the most economical manner possible. These figures are really a comparison of two distinct methods of selling the farmer his plant food. If it was found that a difference of 30 per cent or more existed between two methods of supplying families with flour or sugar, would it not become a subject of active thought and investigation?

What is the explanation of these figures which I have cited as relating to the fertilizer trade? So far as I understand the matter, it is this: on the one hand, the ordinary retail trade in factory-mixed goods maintained by an extensive agent system, of both travelling and local agents, which has been used not merely to supply the farmers with the fertilizers for which they asked, but to push the limits of the trade to the farthest possible bounds. Farmers have not only been given the opportunity to buy, they have been beset with arguments calculated to win their attention and confidence. The competition has been intense. Such a combination of advertising and selling has been costly. This method, where all classes of men have been buyers, has involved slow sales and an expensive credit system, accompanied by the usual proportion of losses. All of this expense has been added to the cost of the goods, and inevitably has been met by the consumers.

Granting that it was necessary to force the growth of the fertilizer trade to such tremendous proportions in so short

a time, with a very conservative class of customers, most of whom were ignorant about fertilizers and many of whom could only make purchases on credit, perhaps the results are as good as could have been expected. But has not the time come for a reform? After twenty years of agricultural schools, experiment stations and farmers' institutes, are not our most intelligent and most prosperous farmers ready to shun these unnecessary expenses, this haphazard method of buying, and, after learning what they need, buy it for cash in the cheapest desirable forms that the market offers? The manufacturer certainly should not object to this method. His profits will not be reduced, I am sure. It is the method adopted in the cases of home mixing to which I have referred.

I know objections are made to the home-mixing method of buying plant food. A sweeping argument often made is, "You station men have been advocating it for a long time, and it makes no headway." It has made headway, slow, to be sure, but as rapid as most movements requiring the education of the masses. It is said that the farmers are not well enough informed nor sufficiently provided with capital to buy intelligently and pay cash. This is true of some farmers, and until they, or their circumstances change, they will continue to pay the tribute that has always been exacted of poverty and ignorance. The claim is made that farmers cannot mix fertilizers so that they will handle satisfactorily, because when thus prepared they are either not fine enough to be used with seed drills or because such concentrated materials become sticky after keeping and stirring. Both of these difficulties can be obviated by proper precautions, as observation and experience have shown. But home mixing is not a condition essential to a more rational method of buying plant food. If the manufacturer is willing to do so, there is no reason why he should not mix any formula which a farmer, or any body of farmers, may desire to use; nor is there any reason why a special contract should not be made with a manufacturer to sell a certain quality of some existing brand of superphosphate, provided it represents what the farmer believes he needs, and can be bought as cheaply as

the same materials can in any other way. It is doubtful if the purchase and home mixing of raw materials can be done profitably by farmers who use each year only a few hundred pounds of fertilizer. But there are hundreds of farmers who buy commercial fertilizers by the ton, who, either alone or in combination with their neighbors, can richly afford to adopt this most rational plan. It is high time to stop buying tons of fertilizer and to begin to buy pounds of the needed elements of plant food; stop paying a premium on names and trade-marks, and consider only the necessities of the soil with which we have to deal.

(6) And now, in conclusion, I exhort the farmers of Massachusetts to remember that the amount of plant food which they buy is small compared with that which they handle, or which exists within the resources of their own farms. If there is a farmer in this audience who annually produces 50 tons of hay, 150 tons of silage corn, 500 bushels of oats, 15 tons of oat straw and 200 bushels of potatoes, he is yearly storing in his barn and grain bins approximately 3,000 pounds of nitrogen, 1,200 pounds of phosphoric acid and 2,400 pounds of potash, or 6,600 pounds in all. It would take of the average superphosphate 50 tons to supply this nitrogen, 7½ tons to furnish the phosphoric acid and 24 tons to replace the potash taken from the land by these crops. If the farmer keeps live stock, his purchased supply of fertilizer will scarcely exceed 2½ tons, containing about $\frac{1}{7}$ of the total weight of plant food actually used. The other $\frac{6}{7}$ have been withdrawn from his soil supply. These materials are a part of his stock in trade, plant-building compounds which are travelling in that never-ending round from the soil to the plant and from the plant to the soil. Of this 3¼ tons of commercially and agriculturally valuable compounds, what proportion will find their way to the soil again? A part will be lost in the products sold, — this can scarcely be avoided, — the extent of the loss depending upon the business which the farmer is doing. But what about the larger proportion of manurial value which is stored in the barnyard or barn cellar? How fully is this preserved for use? How great is the loss by fermentation, by leaching, by failure to utilize to the best

advantage that which actually reaches the soil? In this illustrative case, the plant food brought into use annually would cost over $700. What proportion of this is wasted, to be recovered by a cash purchase, if recovered at all? I leave these questions with you, without further comment, for it was not my purpose to discuss in detail this side of the fertilizer question.

Allow me in closing to express my pleasure at meeting with a New England audience. I am not insensible to the honor which this opportunity confers, and I trust that the attitude of criticism which I have felt impelled to take will be charitably interpreted, and that I shall be credited with endeavoring to promote the interests of agriculture in this Commonwealth.

The CHAIRMAN. The subject which you have heard so well and so fully presented, as shown by the fixed attention of the audience, is open for discussion.

Mr. B. P. WARE (of Marblehead). I have been much gratified with the boldness, justice and truthfulness of this lecture, and I consider its argument in favor of the farmers buying the raw materials and mixing them themselves unanswerable. I know by experience that in that way farmers may save thirty-three per cent of the cost of mixed fertilizers, and may procure the proportions of the different elements of plant food that they believe they need, which they cannot do in buying the mixed fertilizers as put upon the market. It has been said by dealers that the thirty-three per cent is necessary to make up the loss of bad debts, to pay the expenses of travelling agents, etc. That may be true, but who of us are under obligation to pay that thirty-three per cent? I do not feel that I am. It is my duty to myself to fertilize and produce my crops at the least possible cost. I know by my own experience that it is only necessary to have a barn floor, a good reliable man and a shovel, and you can mix your material for fifty cents a ton, and do it well. When that address has been published, you may refer to it for details with the assurance that the advice is sound and may be relied upon. The speaker objects to the

publication of the cash value of the materials used in commercial fertilizers. I differ there. I believe it is a great help to farmers to have a column alongside the selling price for which these different brands are sold giving the commercial value of these materials. It is true, as he has said, that the farmers have the tables of the commercial value of all these ingredients, they have the proportions in mixed fertilizers, and, sitting down with slate and pencil, they can figure it out themselves. But they do not. In looking over a table published in a Rhode Island experiment station bulletin, I found one column that contained the figures of the cost of the material and another of the value; and one special brand that sold for fifty dollars contained ingredients to the value of eleven dollars only. Are you farmers willing to pay forty dollars profit to the fertilizer manufacturer? It sounds big. A commercial fertilizer sold for fifty dollars a ton. That must be the thing I want; I want the very best there is, I will take that; and the farmers do it without going into detail, and figuring up for themselves and ascertaining the great difference between the value and the cost. Let the law protect the farmers to the full extent, and have a column of the cost of the ingredients. If not a necessity, it certainly is a great help. It has been eliminated in our method. The fertilizer manufacturers requested that it be eliminated. I wish it might be reinstated.

Mr. Edmund Hersey (of Hingham). This subject is really one of the most important which can engage our attention. It is a subject to which we have not given sufficient attention, and one which grows more and more important every year. I listened to this very able paper with great pleasure and profit. I think we need a good deal of stirring up in regard to this matter of commercial fertilizers. I was glad to have the speaker bring out so plainly the absurdity of the manufacturers telling the farmers what their soil needs to enable it to produce the best crops. One man will purchase a potato fertilizer which contains certain proportions of the three elements of plant food, and after trial give his testimony telling how much

better it is than any other fertilizer. This, with others, is published in pamphlet form for distribution. Then you take up another pamphlet, and you find another fertilizer with testimonials of others who have used it for their potatoes, and they have all found it to be the best; and so you go on with perhaps twenty of them; and it seems to me that the farmers ought to wake up to the fact that they themselves have something to do in regard to this matter. I speak on this subject perhaps more feelingly because I have had some experience in mixing fertilizers for plant growth, and the fact that at first I went wrong, that I put onto my land materials that the crop did not want, simply because I had in a measure been led astray by the opinion of others who seemed to take the ground that they knew what everybody wanted. I went into a series of experiments to test my soil, — just what every farmer present ought to do before he buys a single ton of commercial fertilizer. If he is going to use them, he ought to understand something about the character of his soil. He ought to understand whether he needs to buy a large proportion of nitrogen, of phosphoric acid or of potash. I found that I was spending money, which was worse than thrown away, by using mixtures which I had been told were all right. I tested my soil by careful experiments, — experiments which can be tried by you all if you will take the separate raw materials and put them on in strips and then make different combinations. You are intelligent enough to do this. If you are not, then let me say to you, do not buy commercial fertilizers, but stick to barn manure, and do only that amount of farming which you can do by using the fertilizers from your own farm. Do not pay money for commercial fertilizers that you do not understand, that you cannot look on the tag of the bag and with your pencil cast up the value of the contents of the bag. I cannot agree with my friend Mr. Ware that there should be legislation to permit the farmers to be ignorant. I want that legislation which will have a tendency to lift them up to a higher level, and I do not care if it compels them to be more intelligent than they now are. My advice to the farmers has always been, "Never touch a bag of commercial fer-

tilizer until you can tell what the three elements that are in the bag are worth." I want to say that I think the results of the experiments on my farm have made the difference between failure and success in running it. Although the farmers grumble about the last year, — and it was a hard year, I will admit, — my farm, by direction, by hiring all the labor, and by buying all the materials, brought in a handsome income on the amount of capital invested. This I attribute to the fact that I have been able to feed my crops better than I could by guesswork; and yet I feel sensible of the fact that I have but just crept up over the elevation which shows me the broad field of investigation which opens before me. We are but just starting out on this work, we are just beginning to learn, and yet the very little which I have learned has saved me hundreds of dollars. I beg of you to test your soils and use your commercial fertilizers to better advantage than by guesswork, and by what other people, who have never seen your land, tell you that you want.

I have a piece of land that has been fertilized for eighteen years in succession with nothing but commercial fertilizers, not one particle of barn manure. Everything has been bought that has been put on it for eighteen years, and yet the cost to me for fertilizer has not been more than two-thirds what it would have been had I relied on guesswork.

Question. What crop was grown on the land?

Mr. Hersey. I have grown asparagus on it. Asparagus is not considered a very good crop to-day. Prices are low. Yet, with the amount of fertilizer that I put on, with some knowledge of what the soil will furnish, my crops increase every year, the soil grows richer and a fair profit is secured. I hope that this lecture will stir you all up to try to make a little progress in regard to this matter, so that, if you come to this meeting next year, you will feel that you know a little more about what your crops need to be fed with than you do to-day. I think that I shall.

Secretary Sessions. I noticed the speaker referred to some difficulty which chemists have in determining the quality of nitrogen. I wish he would explain to us what

he meant by it. Some of us feel that agricultural chemists ought to know everything.

Professor JORDAN. The agricultural chemist is one man who is willing to confess that he does not know everything. He has come to the point where he is obliged to make this confession. What I referred to is this. There is a vast amount of the very best nitrogenous material in the market for use by farmers, but it is sad to relate that through the efforts of designing men there has come upon the market a certain amount of material which is not high grade. You know leather contains nitrogen, you know wool contains nitrogen, you know hair contains nitrogen. But there is a vast difference in the usefulness of these nitrogens. What the chemist ought to be able to do is to pick out of these mixtures that come into his hands the nitrogen that is good, that which is indifferent and that which is worthless. While the chemist can get at some indications of the value of organic nitrogen, that is practically all that he can do. He can determine the amount of nitrogen without saying what form it is in. That is a pretty bad plight. I think Dr. Goessmann will agree with me. We wish we were in better condition to serve the farmer. I am as frank to confess the shortcomings on our side as I am on the fertilizer manufacturer's side. It is not long ago that an enterprising young man in Connecticut found out what seems to be a fairly reliable way to determine whether insoluble phosphoric acid comes from bone or rock. The results published seem to indicate that. I hope there is ingenuity enough in the chemists of this country to find out a fairly approximate way to tell whether nitrogen comes from leather or from blood. Now, we cannot do it.

Mr. C. B. LYMAN (of Southampton). How can we know the value of the different potashes, sulphate and muriate, except by analysis, and how can we tell what foreign substances are in them any better than in mixed goods? Is there any better safeguard in buying raw materials than in buying manufactured goods?

Professor JORDAN. I do not think there is any safeguard in buying raw materials, except the guarantee under which they are sold and a subsequent analysis. If you are wise,

you will buy nitrate of soda on a guarantee, you will buy acid phosphate on a guarantee. That is what you do with mixed goods. I do not bring forward home-mixing as a means of securing safety, but rather as a matter of economy of purchase. I would deal with reputable, well-known men in any case, and their guarantee is as good in one case as it is in another.

Mr. BARTHOLOMEW (of Connecticut). Our speaker has been telling us of the different sources from which to procure available phosphoric acid. If we are to mix our fertilizers ourselves, from what source is it best to get phosphoric acid? One source is South Carolina rock, another source is Thomas slag powder. I am rather doubtful whether the latter is very valuable.

Professor JORDAN. I can well understand that Mr. Bartholomew has doubts about being able to obtain desirable results from the slag, if he expects immediate returns. If I get a pound of phosphoric acid that is useful, I would as lief have it from one source as another. I would buy acid phosphate, if I were to buy to mix myself. Thomas slag is a material insoluble in water. It has been in the market under various names. For seeding down perhaps it might be useful, but for quick-growing crops I would not advise you to buy Thomas slag under any name whatever. The name will not help it any.

Mr. BARBER (of Bernardston). I have practised home mixing of fertilizers ever since I have been engaged in active agriculture, and I have found it economical and profitable.

Mr. WM. H. BOWKER (of Boston). I did not come here to-day prepared to answer Professor Jordan. I did not know what line he would take, and I do not speak for the fertilizer manufacturers. We have no organization among ourselves. I think it quite unfortunate for the protection and dignity of the trade. We hold as adverse views among ourselves as those the speaker has advocated are to my own. No one can defend many of the practices and customs to which Professor Jordan has referred. They are to be regretted and deplored, but we trust that time will right

these things. All new industries must pass through periods of educational development. When electricity first came out it was recommended for all sorts of things, and we had all sorts of electric nostrums, and the world is not yet free of them. Nevertheless, the true science of electricity has made great strides, emerging from the empirical to the substantial and known. Medicine has suffered in the same way, and still there are quacks; but the great science of medicine has steadily progressed, and now we respect the physician and his work. I hope the day will come when chemical and fertilizer manufacturers will be respected in the same way. I have attended these meetings for twenty-five years. I was in this very hall seventeen years ago when this subject was under discussion before this Board, and we have made some progress since then. I am glad that Professor Jordan has been so frank and straightforward. I expected he would be. He has told you that there are different forms of nitrogen and phosphoric acid, more or less available, which the chemists cannot distinguish, and that you have got to rely upon the reliability of the man who sells you the mixed goods, or even the raw materials, for the analysis does not tell the whole story in either case. When that is fully realized, the fertilizer business will be worth doing and brands will mean something. When I buy a barrel of Pillsbury's flour or a bag of Cleveland linseed meal, I know what I am getting. I know that back of that flour or back of that meal is a concern that has a large capital at stake and a reputation which has cost thousands of dollars to build up, and which it could not afford to jeopardize by any dishonorable transaction. The same is true of the large fertilizer manufacturers.

Now, one word as to valuations. Mr. Ware regrets that we have dropped them in Massachusetts. Professor Jordan cannot defend them, nor can any chemist or conscientious State inspector who has looked into the matter carefully. They would not have been abolished in Massachusetts, if good reasons had not been given. Our chief argument was this: we said, if you do a sum on a blackboard every day for a boy, he will never know how to do it for himself. So

as long as the stations figure out valuations for the farmers, just so long will they look to the money column and skip the chemical column, which is the truly educational one. You cannot teach what nitrogen, phosphoric acid and potash mean, their relations to each other and to crops and soils, by computing them in dollars and cents. Finally, we said that the State in its police duty had no right to go beyond a statement of what it found, — that this was the beginning and end of inspection. If the question of making valuations is ever taken into court, it will be thrown out; it will have no standing.

I am an honest believer in special manures. I do not want to say a word that shall appear to advertise, but I say that I am a disciple of the apostle of special fertilization, namely, Prof. Levi Stockbridge of Amherst. Some day we shall erect a tablet in memory of the man who had the courage and the keenness of vision to formulate a principle for our guidance in this work, and which we have called for many years the Stockbridge principle. It will live long after we are dead, because it sets up the only true standard for the feeding of crops and the combining of plant food. It is this: "Supply the crop in suitable proportion, association and form with that plant food which it requires, and which it cannot obtain for itself from the soil or air in sufficient quantity, the supply being based upon the analysis of the crop and its habits and conditions of growth."

Now, this takes the plant, the living thing, and not the dead soil, as our starting-point. You will observe that it also includes the air and the soil, as well as habits and conditions of growth. Up to this time we had been groping for a standard. Peruvian guano was a sort of standard, and fertilizers were made to imitate it. Then Professor Liebig came out with superphosphate of lime or dissolved bone, which formed a standard, but it contained only a limited amount of nitrogen and no potash, certainly unbalanced and arbitrary.

Now, I want to ask Professor Jordan what standard he recommends. If we do not take some guide, as the man said in Congress, where are we at? Professor Jordan will bear me out in the statement that the farmers of Maine

went to him for many years for formulas, and finally he had the courage to make several. Of course they were not based upon the analysis of the crop, for evidently he does not believe in that, but what was his starting-point? Why does he recommend two or three different grades, and especially a fertilizer for seeding down? As a manufacturer, I do not care whether we take the plant, the air or the soil as the standard, — only give us some standard. If we are still in the dark, and the living plant is not a sure guide, for Heaven's sake do not let us grope any longer. The professor says, "Work from your soil." How many of you possess any sure knowledge of the chemical constituents in your soil? I have been at it for fifteen years on my Barre farm, and yet I do not know what it contains or does not contain.

If you take the soil as a guide, the law of minimum comes into play, and what is that law? To illustrate, the strength of a chain is measured by its weakest link. The strength of the soil is measured by the minimum quantity of any one essential ingredient of plant food. You may have sufficient nitrogen and phosphoric acid in the soil, but lack potash, and your crops will fail on that account. That is, the potash may be the minimum quantity, and it is the minimum amount of any one ingredient that controls the final result. The crop tells you what it finds, not what is left in the soil. It may have thrived by applying potash this year. Next year you apply potash, but it fails because there was not a sufficient quantity of nitrogen. The plant tells you what it finds, and not what is left. You do not feed the stable in which the cows stand, but you feed the cows themselves, and vary their rations if they are making beef or milk. As a matter of insurance, I believe in supplying well-balanced, complete fertilizers, based upon the wants of the crop. You may be applying an excess of some one ingredient by this method, but the cost is small compared with the loss of a crop. You have ploughed, planted, cultivated, controlled every factor so far as you can; and yet, for the lack of a little nitrogen or potash which you might have added, with little extra cost, your harvest is a failure. Is this the course of the thrifty, prudent husbandman?

Sir John Lawes of England has been quoted here to-day. I have visited his place twice. He has a soil composed very largely of a disintegrated rock, rich in potash. It has been cultivated for a long time, and each year furnishes sufficient potash for his crops. But Dr. Lawes is the founder of one of the largest fertilizer manufactories in the world, perhaps the largest, known as the Lawes Chemical Manure Company. What is the practice of this company? If you take their catalogue, you will find there listed special manures. I asked the manager why he manufactured special manures, and his reply was that the average farmer throughout Great Britain cannot determine what his soil lacks, and as a matter of business policy it is safer and more satisfactory to supply complete and well-balanced fertilizers for different crops or classes of crops.

Another point: it is probably known to you that, if you apply a ton of fertilizer to the acre, by no chemical test can you find where that fertilizer was applied, the quantity being so small, as compared with the great bulk of soil with which it is mixed, that our means of analysis are not delicate enough to discover it; and yet we know that when we apply even so small a quantity as two hundred pounds, it will, if applied at the right time, turn an apparent failure into a success. Hence, when we find that so small a quantity will turn the scale, it seems to me rational that we should take the crop, the living thing, and not the dead soil, as our guide, using a special and well-balanced manure. The tobacco farmers who are here to-day would not think of raising tobacco except by a special mixture, specially prepared. The asparagus growers of Concord know that a certain mixture, prepared according to the analysis of the plant and its habits and conditions of growth, will give them better results than a general fertilizer. Mr. Shaw of Raynham knows that is true of asparagus.

Mr. Shaw. Yes, sir.

Mr. Bowker. And he is one of the most successful asparagus growers in the State.

I have had experience in the fertilizer business for nearly twenty-five years, and I want to tell Professor Jordan that

I shall be very cautious and slow of abandoning a standard which I know has succeeded, and taking up some arbitrary standard of which I am doubtful.

Now, one word as to the associations of plant food. Dr. Goessmann tells us that sulphate of ammonia and muriate of potash brought into the same combination is not successful, and proves it by experiments. Dr. Fisher of Fitchburg, one of the clearest and most careful investigators, not only bases his formulas upon the analysis of the crop and its wants, but is particularly careful to have the right associations, and he recommends sulphate of potash in some cases and muriate in others. He is very successful in growing fruit. Down in Connecticut Mr. Hale is very successful in growing peaches. I do not know that he is a believer in special fertilizers, but in practice he has found that a special mixture for the peach orchard, very rich in nitrogen, is what he needs for a profitable crop, and the analysis of the crop must have been his starting-point. Moreover, I think he prefers certain forms of nitrogen to others. Even Professor Jordan, in the formulas which he recommended for Maine, prescribed certain forms of plant food. He did not recommend as much potash as some do; but right across the line in New Hampshire another State chemist, Professor Whitcher, recommends a formula very rich in potash. When doctors disagree, what are the laymen going to do? We cross the line into Massachusetts, and Dr. Goessmann, our State chemist, practically recommends special manures. In his great paper on "Grass," read at Springfield several years ago, he laid down the quantity exhausted by a ton of hay. He has repeatedly spoken of the importance of the form and association of plant food, especially in fruit growing. We cross the line into Rhode Island, and there we find a bright young doctor, at the head of the experiment station, who is recommending lime. He almost has it on the brain. Hasn't he, Professor?

Professor Jordan. I will explain that later.

Mr. Bowker. We cross over into Connecticut, and we find Dr. Johnson, the father of them all, also speaking in high terms of lime in connection with other plant-food

ingredients; but Dr. Jenkins, his great disciple and scholar, has been for two years or more carrying on most interesting experiments along the line of special fertilizers in raising tomatoes and lettuce. Professor Jordan will tell you, however, that these experiments are conducted on artificial soil, made up of coal ashes and peat; but Professor Jenkins is using special mixtures, based upon the analysis of the tomatoes and lettuce, and he is getting abundant and splendid results.

I want to put this question to every farmer here to-day. When you leave this hall, what do you propose to use as a fertilizer, what do you propose to buy? If you buy a mixed fertilizer, shall it be a special one or some haphazard one, based upon an arbitrary standard? Or, if you buy the raw ingredients, how will you mix them, with reference to your soil? Do you know anything about it? Or with reference to the crop, of which there have been thousands of analyses which are at your service? I repeat again, Where are you at?

My quarrel with the directors and the doctors is that they do not give us a standard. When you are sick, you call in a physician. He looks you all over, appearing very wise, and finally says, "I think your system is strong enough to carry you through all right without anything," but you keep growing worse. Then he begins to experiment with you, trying first this thing and then that, until you get disgusted and dismiss him. Then you send for a physician of experience and sense, and he follows out a line of treatment founded upon well-established laws and experience; that is, some standards which have grown out of studying the living person, and not his dead and inert environments, although these to a certain extent are taken into account. If the professors or some of them will not take the living plant as their standard, then find something that we can adopt. Don't let us flounder any longer. We pay these State chemists handsomely. The fertilizer manufacturers, as well as the farmers, are taxed for the support of inspection; and we therefore have a right to expect from them some system, some plan, that shall be safe, economical and successful, — some system of plant feeding that

shall insure a crop, so far as man is able to do it. But until we do find something which is better, I, for one, shall hold fast to the principle which makes the living crop and not the dead soil its starting-point.

Professor JORDAN. After my friend Mr. Bowker commenced, I thought the lion and the lamb were going to lie down together in the nicest way you ever saw, but he quickly changed the atmosphere. If I get into trouble with the New York Legislature next winter, I have found out whom I shall send for to make my argument by taking up the time trying to prove things that have no relation whatever to it. I say that in admiration of the abilities of our friend, rather than disparaging them.

The physician is one of the poor abused creatures of this world. He deserves it sometimes. If a physician finds a disease to be typhoid fever, he treats it accordingly. I stand on that platform. The thing which I will not do is what some physicians do, — say that I do not know what ails the patient, but I have a dose that will cure anything, and, whether it kills or cures, I am going to put it into him. Our friend tells us we station men must have a standard. But, to go back a little, if my farm has typhoid fever, I cannot cure it by applying remedies for diphtheria.

We are told that we must present to these fertilizer manufacturers a standard, and I am quoted as one who presented to the State of Maine a standard. That is a little unkind, because there were several hundred tons of Brother Bowker's fertilizer sold under that standard, and I hope he made something out of it; and when he knows the objections I made to that standard, when he knows that I felt it was irrational, when he knows I did not believe in it, he comes in and introduces me as making a standard. I say, friends, that is not fair. When the committee, the State Grange of Maine, came to me and said, "We want to contract with some reputable firm" (they did contract with a reputable firm) "for several hundred tons of fertilizer, and we want you to make a formula," I said, "Don't ask me." I did not want to give a formula, because I do not believe that the same fertilizer is the best thing for every man in the State of Maine. The farmers said, "We have

got to make a contract, and we must choose the lesser of two evils, and you must help us out." I had more unhappiness under that thing for the space of forty-eight hours than anything I ever undertook to do. I finally made a formula, and I tried the best I could to average up things. They were buying into Maine cotton seed, linseed meal and gluten, — immense quantities of nitrogen outside of what they buy as fertilizers; so I put in a large portion of phosphoric acid. I had seen on many farms of Maine the need of phosphoric acid. We have a granite soil up there. I made a formula the best I could, but against my best judgment as to the desirability of a fixed formula for a State.

About this lime business in Rhode Island, I do not see that that has anything to do with this question.

Our friend has argued both sides for me in the case of special fertilizers in forcing houses. I would take the same position myself. Where you have an artificial soil to make, where you must supply all that a plant gets, as is the case in forcing houses and under the high-pressure system of the market gardeners, I would have regard to what the crop contains. I am not ready to say, with the tremendous diversity of soil, that we want to reduce everything to a standard. If one man is a dairyman, and raises corn, wheat and the like, I do not believe he should buy the same mixtures as one who does not buy cotton-seed meal, and I never have seen the reason for giving that advice.

Adjourned at 12.30 P.M.

Afternoon Session.

The meeting was called together at 2.15 P.M. by the secretary, who said: The time has more than passed when we should start the programme. You will remember that President Grinnell announced that Vice-President Appleton would preside to-day.

Chairman Appleton. Of course you know that President Atherton has done a great deal in the work of agricultural colleges and experiment stations. He has done a great work, and he comes to us to-day as president of the Pennsylvania State College of Agriculture and Mechanic

Arts. It gives me a great deal of pleasure to have the honor of presenting to you at this time President ATHERTON, who will speak to us on the subject "The future of New England agriculture."

President ATHERTON. Gentlemen of the Board: It is a great pleasure to stand before a Massachusetts audience, for I am a Massachusetts boy, and I never come across the line into Massachusetts without recalling the days that I spent as a boy on the farm in Essex County. I think my sympathies and associations fairly entitle me to go a little beyond, and speak of the schools of New England, for I spent the first years of my life in New England; went to college in Connecticut and fitted for college and did my first teaching in New Hampshire, so I think I have had a pretty good round-about training. Then I served during the war near the Twenty-third, Twenty-fourth and Twenty-seventh Massachusetts regiments, so I have kept in pretty close touch with New England. While in recent years my field of duty has lain elsewhere, I have never lost my respect and something of veneration for the old home.

In speaking this afternoon on the subject which has been assigned to me, I find myself laboring under some disadvantages that I am not responsible for altogether, and which I think I shall have to charge to our friend Sessions. I have to read from manuscript, which is always a burden and a weariness to the audience, if it is not to the speaker. In fact, a New England audience as a rule does not care very much about manuscript except on Sundays, and not so much then as they used to. But the secretary was careful to impress upon me that what I might prepare to say to-day I must also prepare to look at in cold print afterwards.

You will notice another thing, which is of a great deal more importance; the subject seems to call for prophecy, but I make no claim to the gift of prophecy. The only thing I have hoped I might be able to do was in some measure to state the conditions in the midst of which we are living and which are likely to continue, and then we may judge for ourselves what measures must be adopted in order to meet these conditions wisely, and from them secure the largest possible results.

The Future of New England Agriculture.

BY GEO. W. ATHERTON, LL.D., STATE COLLEGE, PA.

The subject upon which I have had the honor to be invited to address this distinguished body is not one respecting which I can claim authority to speak as an expert investigator; but as we are all alike ignorant of the future, my hope is that a correct interpretation of present and past experience may enable us to make some intelligent forecast of the direction in which certain powerful tendencies are likely to continue to operate. If this end can be attained, I venture to indulge the belief that we may thus discern with some clearness the path along which progress and prosperity lie.

Into every question respecting agriculture two great factors enter, — nature and man. Of these two, nature is constant; man changes. The seasons come and go in their appointed order. The sun shines, the rains and the refreshing dews descend, the breezes blow, and under these vitalizing influences seed-time prepares the way for harvest, and generous Mother Earth yields her increase. There are, especially in respect to climate, of course, exceptions. Too much or too little rain may fall; a late frost may spoil the first seeding, or an early frost may injure the harvest; heavy crops may glut the market and lower the price, or a long and severe winter may exhaust the stock of hay and fodder. But, in the long run and in the large view, these variations are, in New England, minor and incidental. The great forces and operations of nature move on, unhasting, unresting, running in the invisible groove of unvarying law, but ministering freely to the needs of man and docile to his service. Even the soil itself, if unused, becomes

richer, and if intelligently used need not become poorer; as witness the fact that the yield of wheat per acre in France has doubled since 1789. In any inquiry, therefore, as to the future of agriculture, in New England or elsewhere, so far as the future is to be contrasted with the past or the present, nature may be left wholly out of the account. What it has been it will continue to be. The climate, the soil, the seasons will remain practically unchanged, and will serve in the future the same basis and groundwork as in the past for all the activities of man.

On the other hand, man, the second factor, changes incessantly. Not only the slow and silent process of change in the inner life of the individual, but the more obvious change in the structure and movement of society — the collective man — goes constantly forward. The progress of both individual and collective man is a perpetual struggle to understand, control and bring himself into better adjustment with his material environment. The *rate* of his progress is accurately measured by the increasing degree of his control over the forces of nature; and the net result of these two sets of great and ever-present reactions — the individual upon society and society upon the individual, and both of these upon nature and nature upon them — makes up the sum total of past history and includes the whole of future advancement.

These statements are so nearly self-evident that no one probably will be inclined to question them. They are introduced merely for the sake of fixing attention upon the fact that the changes heretofore wrought in the condition of agriculture have been the work of man, and that any future changes must be also made by him and subject to his control; not subject to his control as an individual, of course, but as a community. And we must accordingly inquire what are some of the great social forces which have produced the results which every one now observes, and to what extent they are likely to continue in operation.

The most obvious and striking fact in the social history of recent times is the continuous and accelerated tendency of population in every civilized country to gather in groups,

larger or smaller; and, in general, the larger the group, the more rapid the rate of increase.

For example, in 1790, at the taking of the first census, there were in the United States only 6 cities having a population of 8,000 and upwards. In 1880 the number of such cities had increased to 286, and during the next ten years it had leaped from 286 to 448, an increase of more than 56 per cent. And not only did the *number* of such cities increase at that enormous rate during a single decade, but the urban population itself increased at an even greater rate, namely, from 11,318,547 to 18,284,385, or 61 per cent.

In 1870 there were but 14 cities containing more than 100,000 each; in 1890 the number was 28, or just double. In 1880 again there was only 1 city with a population of upwards of 1,000,000; in 1890 there were 3 such cities, — New York, Chicago and Philadelphia.

To state the general fact in another form, the urban population (that is, the population in cities of 8,000 and upwards) was, at the time of taking the first census, only 3.35 per cent of the total population of the United States. Fifty years later, the census of 1840 showed that by a very slow rate of increase the urban population had reached only 8.52 per cent of the total, but from that time forward the rate of increase was much more rapid, and in 1890 the percentage of such population was 29.20. In the North Atlantic division, however (which includes New York, New Jersey and Pennsylvania, with the New England States), the percentage of urban population is much greater than the average throughout the country, being 51.81 per cent. In the New England States the percentage varies greatly, being 19.72 in Maine, 27.37 in New Hampshire, 7.93 in Vermont, 69.90 in Massachusetts, 78.89 in Rhode Island and 51.63 in Connecticut, the general average for these States being 52.81 per cent.

So marked has been this tendency toward the concentration of people in cities that upon 16 per cent of the area of the whole country the rural population actually diminished between 1880 and 1890. The diminution was greatest in New York State, where nearly five-sixths of the area

lost rural population. In Vermont more than three-fourths of the area lost, and in Maine and New Hampshire nearly two-thirds of the area. In Massachusetts the area covered by such loss was relatively small, being slightly less than 19 per cent of the total. The *numerical* decrease of rural population in New England during that decade was: in Maine, 24,391; in New Hampshire, 8,575; in Vermont, 18,944; in Massachusetts, 6,552; in Rhode Island, 508; in Connecticut, 11,964, — being a total of 70,904; but during the same period the aggregate population of these States increased 690,216.

As has been already indicated, this tendency to a rapid increase of urban population, as compared with rural population, is characteristic of the history of every civilized country for the last fifty years. It is aside from my present purpose to enter into details respecting other countries than our own; but it is obvious that a world-wide movement of such vast sweep and momentum cannot be the result of accident. There must be some adequate cause, either in nature or in the changing forces which impel man; and, since nature is unchanged, that cause must be sought in the changing conditions which man himself is creating. It is not necessary to dwell upon these causes, except as they bear directly upon the question before us; but it is plain to the most casual observation that they furnish the necessary starting-point for all our inquiries in this direction.

It will throw light upon the facts which we have just been considering, if we place side by side with them another class of facts of a different kind, yet equally striking and significant. The same period during which this great shifting of the population has been going on has been the period of the great modern development of machinery and of mechanical appliances of every kind. The wonderful advances of science within the present century (and especially the last half of the century), by means of which it is safe to say man has learned more of the secrets of nature than had been discovered in all preceding centuries combined, has been followed at every step by the invention of contrivances for using these secrets in the service of man.

Every mechanical appliance is simply a device for transferring burdens from the shoulders of man to those of nature. Every machine is a harness in which the forces of nature are made to work. The extent to which machinery can be employed in agricultural operations is limited to some extent, even under the most favorable conditions. But in manufactures of every kind the field for the employment of machinery seems to be limited only by human ingenuity. The steam engine, the telegraph and telephone, the cotton gin, the sewing machine, the reaper and mower and harvester have revolutionized the industrial and the social world. In the days when every farm was a little world in itself there was comparatively little need of exchanging the products of industry, except for such occasional luxuries as must be brought from other lands. But with the distribution of the productive and manufacturing branches of industry among different workers and groups of workers there came an increasing necessity for bringing these separate groups into closer proximity, and for providing the means of prompt and frequent intercourse and facilities for the convenient exchange of products.

It would be interesting to trace the growth of manufacturing industry, in the new world, from its crude and simple beginnings through costly and laborious experiments to its present high state of development. But time does not permit, nor does our present purpose require it; yet, at the risk of a partial digression, I must ask leave to introduce a single extract from an order of the General Court of Massachusetts Bay, in 1640: —

The Court, taking into serios consideration the absolute necessity for the raising of the manifacture of linnen cloth &c., doth declare that it is the intent of this Court that there shall bee an order setled about it, and therefore doth require the magistrats and deputies of the severall towns to acquaint the townesmen therewith, and to make inquiry what seed is in every town, what men and women are skillful in the braking, spinning and weaving; what means for the providing of wheels; and to consider with those skillful in that manifacture, what course may be taken to raise the materials, and produce the manifacture, and

what course may be taken for teaching the boys and girls in all townes the spinning of the yarn; and to returne to the next Court their severall and joynt advise about this thing. The like consideration would bee had for the spinning and weaveing of cotton woole.

Eighty years later, in 1720, at a special town meeting held in Boston, it was voted: —

That the Town will proceed to the choyce of a committee to consider about promoting of a Spinning School or Schools for the instruction of the children of this town in Spinning to be seven in number.

In the face of untold difficulties and hindrances, natural and legal, this tiny germ grew during the colonial period, and from the beginning of the present century the advance of manufactures was steady and rapid. The progress of the last fifty years is fully shown by the census returns, and the following table presents the aggregates at a single glance: —

	Capital Employed.		Number of Employees.		Wages Paid.		Value of Products.	
	1850.	1890.	1850.	1890.	1850.	1890.	1850.	1890.
Maine,	$14,699,152	$80,419,809	22,020	75,780	$7,485,588	$26,526,217	$24,661,057	$95,689,500
New Hampshire,	18,242,114	79,375,160	27,092	63,361	6,123,876	24,248,054	23,164,503	85,770,549
Vermont,	5,001,377	32,763,291	8,445	24,894	2,202,348	10,096,549	8,570,920	38,340,066
Massachusetts,	88,940,292	630,032,341	177,461	485,182	41,954,736	239,670,509	157,743,994	888,160,403
Connecticut,	25,876,648	227,004,496	50,731	149,939	12,435,984	75,990,606	47,114,585	248,336,364
Rhode Island,	12,935,676	126,483,401	20,967	85,976	5,047,080	37,927,921	22,117,688	142,500,625
Total for New England,	$165,695,259	$1,176,078,498	306,716	885,132	$75,219,612	$414,459,856	$283,372,747	$1,498,797,507
Total for the United States,	$533,245,351	$6,525,156,486	957,059	4,712,622	$236,755,464	$2,283,216,529	$1,019,106,616	$9,372,437,283

Comparing the totals for New England with the totals for the United States, we find that in 1850 these six States, with only 11.76 per cent of the capital employed in manufacturing industries and 32.04 per cent of the employees, paid 31.78 per cent of the wages, and turned out 27.80 per cent of the total products. In 1890, with only 7.51 per cent of the population, the percentages as to manufactures were, respectively: capital, 18.02; employees, 18.35; wages, 18.15; products, 15.99.

While these figures show clearly enough the natural connection between density of population and accumulation of manufacturing industries, they fall far short of exhibiting the full truth of the situation, since, out of regard to our general subject, I have included all the New England States in the grouping presented. We have already seen that these States have, by more than 20 per cent, a higher average of urban population than the country as a whole, and the above table shows that their percentage of manufacturing industry is nearly two and a half times their percentage of the total population — (say, in round numbers, 7.5 to 18). But, if we look at the three great manufacturing States of Massachusetts, Rhode Island and Connecticut, the facts are still more striking. Thus, in 1890 the number of inhabitants per square mile for the United States was 21.31, while in Massachusetts it was 278.48, in Rhode Island 318.44 and in Connecticut 154.03. The percentage of urban population throughout the United States is 29.20, while in Massachusetts it is 69.90, in Rhode Island 78.89, in Connecticut 51.63.

Similarly, Massachusetts, with 3.57 per cent of the total population of the United States, has 9.65 per cent of the total capital employed in manufactures and 10.29 per cent of the employees; pays 10.40 per cent of the total wages and turns out 9.15 per cent of the total products. Rhode Island, with .55 per cent of the population, has 1.93 per cent of the capital and 1.82 per cent of the employees; pays 1.66 per cent of the total wages and turns out 1.52 per cent of the total product. Connecticut, with 1.19 per cent of the population, has 3.47 per cent of the capital and 3.18 per cent of the employees; pays 3.32 per cent of

the total wages and turns out 2.66 per cent of the net products.

If such a movement of population and industry (or, to speak more accurately, double movement) as we have been observing had taken place by itself, the relations of agriculture and manufactures would probably have readjusted themselves without any serious shock to the former. But contemporaneously with it there has been going on a third movement, quite as marked as either of the others, and far more influential in its effects upon social, political and industrial conditions. I mean the rapid development of a vast area, once vaguely known as "the west," but now the centre of population and the seat of political power for the whole country. For a long period that region was almost entirely agricultural, and a large percentage of the people are still engaged in that industry. The fertility of its soil and the wealth of its natural resources, exploited by a vigorous race drawn from the best stock of the older States and of Europe, has poured out a supply of food products with which the New England States cannot compete, especially since the sharp rivalry of railways has brought down the cost of freight to the almost incredible rate of one cent per ton per mile. Add to this the fact that so large a number of the most ambitious and energetic of the youth of these States have joined the westward-moving throng, and that such vast amounts of eastern capital have been invested there, and one might also be tempted to say that New England had been setting in motion the forces which would ultimately work her own destruction.

But such a view is narrow, short-sighted and false. It is the wail of the pessimist, not the well-considered judgment of a careful observer. The acreage of farms in the United States has somewhat more than doubled from 1850 to 1890 (increasing from 293,560,614 acres to 623,218,619, or 112.29 per cent); but during the same period the value of farm implements and machinery in use has more than trebled (increasing from $151,587,638 in value in 1850 to $494,247,467 in 1890, — a gain of 226.04 per cent), and if we take into account the *decrease in the cost* of such machinery during that forty years, it is probable that there

is at least *five times as much machinery used* now as there was in 1850. The consequence is that, with twice as much land under cultivation, it takes ten per cent less men to do the work; and this reduced number of men is feeding more than double the population of 1850, besides sending enormous quantities of food products abroad, the exports of agricultural products in 1895 amounting to more than $570,000,000 worth. The beneficent homestead law has, of course, been a powerful factor in increasing the number of farms, having added more than 2,000,000 to the number and the timber culture acts another half million, and the increase has accordingly been far greater in the new west than in the settled communities of the east. But New England has fully shared in the general prosperity, and, as we have already seen, has more than made up in other directions any relative falling off in agriculture.

The number of acres of farm lands in these six States increased from 18,367,458 in 1850 to 19,755,584 in 1890, or more than a million and a quarter acres; while the valuation increased from $435,154,525 to $585,267,817, — a gain of $150,113,292, or an average of $108.12 per acre for each acre of additional land included in farms. The increased valuation was distributed among the several States as follows: Maine, $55,495,252, or 83.01 per cent; New Hampshire, $13,775,552, or 20.73 per cent; Vermont, $23,055,633, or 29.28 per cent; Massachusetts, $25,743,-761, or 21.11 per cent; Rhode Island, $6,078,839, or 31.83 per cent; and Connecticut, $25,964,255, or 31.63. The total acreage in farms was increased in three of the States and decreased in three, as follows: Maine increased 1,624,532 acres, or 35.67 per cent; New Hampshire increased 66,604 acres, or 1.96 per cent; Vermont increased 269,824 acres, or 6.54 per cent. On the other hand, the acreage in Massachusetts decreased 357,730, or 10.65 per cent; in Rhode Island, 84,657, or 15.28 per cent; in Connecticut, 130,447, or 5.47 per cent. One of the most striking facts shown by a comparison of these figures is that the decrease in acreage in the three great manufacturing States is accompanied by a marked increase in valuation. Massachusetts, for example, shows a decrease in acreage of 10.65

per cent, but an increase of valuation amounting to 21.11 per cent. The decrease in Rhode Island was 15.28 per cent, but the increase in valuation was 31.83 per cent; while Connecticut, with a decrease of 5.47 per cent in acreage, gained 31.63 per cent in valuation. A fact which throws much suggestive light upon the real condition of farmers in New England, and explains their stability and independence, is that they are so largely owners of the farms which they cultivate. In Maine 94.56 per cent of all the farms in the State are cultivated by owners; in New Hampshire, 92.03 per cent; in Vermont, 85.40 per cent: in Massachusetts, 90.70 per cent; in Rhode Island, 81.27 per cent; and in Connecticut, 88.46 per cent. This is considerably above the average for the whole United States, which is 71.63 per cent.

At the risk of wearying your patience, I must mention one other item of agricultural advancement, which is not only highly significant in itself, but furnishes an explanation of many of the changes that have taken place in methods of farm management. I have already mentioned the astonishing increase in the value of machinery and implements in use on the farms of the entire country. Physical conditions in New England do not admit of the use of such appliances to the same extent as on the smooth plains and prairies of the west, but they have come to be a very large factor in farming operations here as well as there. Their total value in the six States increased from $12,937,390 in 1850 to $23,783,288 in 1890, — a gain of 84.26 per cent. The actual value and the percentage of increase was distributed among the States as follows: Maine showed an increase from $2,284,557 to $5,499,413, or 140.72 per cent; New Hampshire, from $2,314,125 to $3,594,850, or 55.34 per cent; Vermont, from $2,739,282 to $4,733,560, or 72.81 per cent; Massachusetts, from $3,209,584 to $5,938,940, or 85.04 per cent: Rhode Island, from $497,201 to $941,030, or 89.27 per cent; and Connecticut, from $1,892,541 to $3,075,495, or 62.50 per cent. I fear I ought to offer an apology for presenting so many statements in the form of statistics, but they seem to me, like the massed columns of an army, to go straight to their conclusion

with overwhelming and irresistible force. They show that, while New England has been passing through a momentous process of social and industrial transition, the result has been an enormous gain in general prosperity and well-being. I cannot better close this branch of my subject than by quoting a few paragraphs from an article written in 1890 by one of the eminent and honored sons of Massachusetts, Ex-Governor Boutwell. The fact that the U. S. census returns of 1890 had not then appeared will account for his citations from the Massachusetts census of 1885.

In 1880 the population of Massachusetts was 1,783,085, and in 1885 it was 1,942,141. A like rate of increase will give an aggregate of about 2,200,000 by the census of 1890. More important is the fact that the manufacturing industries of the State have increased in a ratio that is far in excess of the rate of increase in population. In 1875 the total horse-power that was employed in manufactures was 219,889, and in 1885 it was 365,012½, — a gain of 66 per cent. In but one county, the county of Dukes, was there a loss, and that was a loss of only 14 horse-power. In 1875 the value of the machinery in the State was $65,500,000, and in 1885 it exceeded $100,000,000, of which less than 5 per cent has been imported. In 1885 there were 23,431 manufacturing industries in Massachusetts, of which 15,561 were established since the passage of the tariff act of 1861; and of these, 5,634 were erected in the years from 1880 to 1884 inclusive. In the same five years 667 factories and mills were erected for the production of metals and of metal goods. The raw material used in manufactures in the year 1885 was valued at a trifle less than $390,000,000, and the value of the goods manufactured exceeded $674,000,000. The leading industries are in cotton, leather and food preparations, and in these the tariff duties play no considerable part except in the wages of labor. These three industries aggregate a total of more than $250,000,000. In 17,125 of the 23,431 establishments there were 419,966 wage earners, who received as wages, in the year 1885, the sum of $147,415,316. The total fixed capital invested in manufactures exceeded $500,000,000. In 1860 the deposits in savings banks aggregated $45,000,000, counting only the millions, and in 1889 there were $332,000,000. The gain in 1889 was $17,500,000. There were 230,000 depositors in 1860 and 1,029,000 in 1889. In 1889 there was an increase of more than 46,000 in the number of depositors.

The prosperity of New England as a whole may be measured by its appropriations derived from self-imposed taxation and expended for education. The report of the commissioner of education for 1888 shows that the amount raised by taxes in New England, in proportion to the number of children of the school-going age, was far in excess of the amount raised in like manner in any other section. The ratio in Massachusetts was to that of the whole country, including Massachusetts, as 2,342 to 699. Again, as to the condition of the agricultural interest, reference must be made to the census of Massachusetts for the year 1885. By that census the agricultural products were valued at $47,000,000, omitting the excesses, as against $37,000,000 in 1875 and $32,000,000 in 1865. From 1875 to 1885 there was an increase of about 40 per cent in the quantity of products and a decrease of about 30 per cent in values. In 1865 there were 68,000 persons employed in agriculture, in 1875 there were 70,000 and in 1885 there were 77,000, of whom more than one-half were proprietors. The wage earners on the land received something more than $6,000,000 in the year 1885. . . .

Another evidence of prosperity is found in the fact that the debts of the New England States were reduced by payment from $26,830,733.35 in 1880 to $7,287,688.36 in 1890, and that three of the six States are free from debt.

I do not overlook the fact that every such readjustment of industry as has been going on and is still in progress works unevenly in individual cases. The very fact that we have to deal with averages presupposes the existence of cases more or less numerous below, as well as above that average level. No social or industrial change, however slight, can occur without involving some degree of wear and friction. The mere sense of being in an unfamiliar situation, of doing unaccustomed things and falling into new relationships, involves, for many persons, a degree of mental and moral hardship which often amounts to real suffering; and when such changes continue over a long course of years, involving not merely slight personal readjustments but the severing of old ties, the breaking of old associations, an entire change of employment, the sense of hardship and suffering and injury are immeasurably increased, and many succumb to the strain, like the worn-out stragglers of an army.

Nevertheless, if, looking again at the industrial host as an

army, we find a progressive forward movement, we know that all the members necessarily share in that movement, some in advance, some in the rear, but all going steadily onward. Such a movement, as has been already clearly shown, has been going on in New England, not merely for fifty years but from the days when the first settlers, planting the first hills of corn, in the manner imitated from the Indians, placed two little fish in each hill, because, as the natives said, corn had been raised thereabout again and again, and the land was now hungry. The hum of New England industry has been heard around the world, and the light of her intelligence has everywhere shone. No people have ever exhibited greater skill in making use of the resources at their command, in creating and utilizing new conditions, and in making each advance a stepping-stone for further progress. The establishment of new industries and the extension of old ones has been a consequence, not of failure, but of success in other employments. The fact that farmers and the sons of farmers have sought the city, that agricultural labor has been transmuted into commercial and manufacturing energy, is simply an evidence that shrewd men, of a shrewd race, have more and more discovered the field in which their forces could be most profitably employed. The discoveries of science, the diversification of industries, the division of labor, the gathering of population in large groups, are all but parts of the same great transition by which the world is passing over from mediævalism to the energy, the activity, the forward and upward push of modern life.

In this transition movement New England has been not only among the sharers but among the leaders. These States now find themselves with a large and increasing industrial population, side by side with a relatively small and diminishing agricultural population. The question for the present, as well as for the future, is, what relation these two great bodies of workers are to bear to each other. It cannot for a moment be supposed that the energy and skill, and foresight and steadiness of purpose, which have created the situation, will prove incompetent to deal wisely with it. These busy hives of industry furnish the best market in the

world for all possible products of the soil. The call for good and better foods, for good and better clothing, for good and better houses and furniture, make an unfailing demand upon the best energies of those who can produce the means of satisfying these desires. Local agriculture, as has been already said, has, for a long time, been unable to compete with the great west in supplying the staples of meat and cereal foods. But the almost unlimited variety of fresh and perishable products, and products in the production of which are required care and skill and patience and training, furnish a field for domestic and near-by agriculture, which is capable of indefinite and almost unlimited expansion. Farming used to be looked upon as a simple and unskilled routine, which could be followed by the dullest as successfully as by the brightest. Any kind of material was thought good enough to make a farmer of. But all that is changed. It is coming to be rightly recognized that there is no field of human employment in which intelligence and training and all the qualities which go to make success in other spheres of activity can be more wisely used, or secure more worthy rewards, than in agriculture. I doubt if an unsuccessful farmer can be found in New England who has brought to his business a fair average of industry, frugality, knowledge and executive ability.

I am fully persuaded, however, that, while the general tendency to gather in city centres is natural and necessary, it is in many individual cases unnatural and undesirable, and young people in the country ought so to be taught. They see *instances* of great wealth or prosperity, and falsely dream that *all* dwellers in the city are wealthy and prosperous.

No one will deny that cities and towns offer many desirable advantages, and many attractions which are not advantages. Many a young man and young woman goes there with profit; but many more exchange a comfortable home in the country for hardship, misery and ruin in the city. Cities are the seats of great industries, great achievements, great virtues and great charities; but they are also full of temptation for the unprepared, snares for the unwary and destruction for the weaklings. They *consume* human life

at a fearful rate. They live "the pace that kills;" they have not the virile force to renew themselves, and, if they were not constantly recruited from the fresh blood of the country, must soon fall into decay.

If I might venture to suggest a few of the necessary qualifications of a successful farmer under such conditions as exist in New England to-day, I should strongly emphasize two or three points.

To begin with, I shall place in the very front rank of such qualifications, as one without which no farmer, whatever his other advantages, can reach the highest measure of success, a genuine love of the soil and of his occupation. In every other field of effort we readily recognize the necessity of an adaptation between the man and his work. He must be drawn to it, not by the mere caprice of circumstances, but because he finds there scope for the full exercise of his mental and moral forces and full range for the play of his spiritual faculties. The danger of mechanical employments is that they make the man mechanical. They tend to deaden the exercise of the imaginative faculty in man, which, whether he be orator, poet, artist or worker, sets him out from the midst of the material things with which he deals and gives him the zest which comes from a sense of mastery and freedom. For some specially gifted minds, indeed, mechanical operations furnish an almost limitless field for the exercise of ingenuity and the introduction of improvements. But "to him who, in the love of nature, holds communion with her visible forms, she speaks" a language of infinite variety and beauty.

As another poet says, "Nature never did betray the heart that loved her." Every form and operation of nature thrills and throbs with ever-fresh life. Whether in the starry night the husbandman looks up to marvel at the grandeur and majesty of the endless procession of the heavenly bodies; whether he watches the clouds which are driven apparently by chance winds, and learns that they too, represent in their form and movement the highest type of law; whether he studies the soil beneath his feet, with its well-nigh limitless possibilities of responsiveness to his touch, or whether he studies the laws of life as revealed in the plants and animals

about him, — the plainest intelligence cannot but feel that he is standing upon the very threshold of the arcana of nature, and permitted to see and touch and understand, as no others can, the secrets of her wonderful laws.

The farmer who comes to his employment with something of this spirit finds himself in the midst of an endless field of observation, study and experiment. He learns the qualities of the soil on different parts of his farm and the crops for which they are best suited, and then, by a corresponding study of his nearest or best market, he adapts the one to the other, with the same intelligent appreciation of means and ends as characterizes the successful man in the highest forms of industrial organization. This implies that, in the next place, he must be an alert and well-informed man of business. He will waste little time in new ventures, but will learn, as promptly and accurately as possible, what he, with his powers and resources, can best do with his farm as it is, — not omitting, of course, a constant and persistent effort to improve it. He will not stake the results of his year's enterprise on a single crop, however tempting its temporary promise of large returns. If he cultivates orchards, he will raise apples, pears, cherries and such other kinds as he understands and his soil is adapted to and his market will absorb. If he turns his attention to small fruits, he will observe the same system of selection and adaptation. If he devotes himself to dairying or stock raising, he will still have enough of reserve in other directions, so that no chance of seasons can rob him and his family of a comfortable livelihood from products of their own raising. He will see to it that every product which is shipped to any market from his farm is so carefully assorted and guaranteed and put up with such care and taste and attractive form that his label will be a passport to the confidence and patronage of the most desirable buyers; and, above all, as a sound business man, whenever he saves one hundred dollars or one dollar he will put it in some safe investment, where it will work for him by night and by day the year round, or he will invest it in the betterment of his property. He will not think of the farm as a place to make money and the city as a place to speculate with it. He will have no

time for loafing and no means to waste on trifling indulgences.

His plans of life having been once definitely formed, he will not be easily swerved from them. A large crop with small prices this year will not discourage him from raising the same crop next year, unless it becomes obvious that some great and permanent change in the market has taken place; and, on the other hand, if he finds a given crop peculiarly profitable this year, he will not greatly enlarge his operations with reference to that crop next year, because he will know that the strong tendencies of human nature will impel many others to do the same, and thus, by overstocking the markets, minimize the profit to all producers.

In order to reach and occupy this high standing ground of manly and contented independence, he will, as far as time and means allow, take pains to keep himself fully abreast with the advancement of agricultural knowledge. He will attend the meetings of the farmer's institutes, of the State Board of Agriculture, of the State and county agricultural and horticultural societies, — not as a passive listener, but to present to his fellow farmers the best results of his own experience and reflection, and to take an active part in the discussions of subjects upon which he is ready either to receive or to give light. If he finds it impracticable to do all this or any considerable part of it, he will at least keep himself acquainted with the printed proceedings of such bodies, will subscribe to a few of the best periodicals, and especially will keep informed concerning the investigations and experiments which are constantly under way at the agricultural experiment stations, established in every State of the Union and supported by the government of the United States. The government spends in that way, in New England alone, $90,000 every year; and the results of this great and fruitful activity are furnished to every farmer who desires them, without money and without price. These investigations are slowly but surely revolutionizing the business of farming, and no man can stand in the front ranks of his industry or profession who does not keep himself familiarized with the best results of the work thus carried on.

The stirring, progressive and prosperous atmosphere surrounding the home of such a farmer will unconsciously but surely prove a most powerful bond of family union and an incentive to loyalty to the homestead and the occupation on the part of sons and daughters. They will grow up with a living sense of the beauty, the dignity and the independence of such a life; and the farmer will see to it that they are so well educated as to be able to take their places as the peers of the children of men engaged in other callings.

One of the greatest needs of the farmer is to form a just appreciation of both his advantages and his drawbacks, and then lay out and follow a plan of life based upon his best judgment. Enlightened by experience, he will be on the alert to take up improved methods, but will steadfastly adhere to his fixed aim and purpose. He will not then listen to the cheap advice of the cheap agitator or the cheap demagogue, whose solicitude for the farmer's welfare ends with securing his vote; who talks volubly of "wrongs," which exist only in his own vapid imagination; and who insults the intelligence and self-respect of every man whom he attempts to patronize, — to the end that he may by the farmer's help secure a comfortable seat at the capitol.

Let the farmer, besides being master of his own business, keep himself well informed on public questions, and then vote for men who have won his confidence by deeds, not words. The truth is, that there is no legislative body anywhere which has not a genuine desire to do whatever will really advance the interests of a class of the community which they fully recognize as its most stable and conservative and trustworthy social force. The farmers can have all the legislation that they really want, when they present a well-considered case; but let them avoid depending on legislation to do things which can be done only by themselves.

What was last said respecting facilities for self-improvement relates to those which are placed within the reach of the active working farmer himself, and these are available to all who can read and think. But, besides these, the United States and the several States, acting in co-operation, have made special and generous provision for the education of the

sons and daughters of farmers and of all others engaged in industrial pursuits, by the establishment of colleges whose leading object is required by law to be "the teaching of such branches of learning as are related to agriculture and the mechanic arts." This necessarily includes the whole range of the mathematical, the natural and the physical sciences, such as botany, chemistry, natural philosophy and other related branches of study, with their manifold applications in the industries of our time. The young man who acquires a knowledge of the fundamental principles of these branches of science has all the theoretical equipment that is necessary for success in carrying on the practical operations of farming. You are to be congratulated on the fact that one of the best of these institutions is your own Agricultural College at Amherst. The breadth and thoroughness of its work, its high standards of training and the eminent qualifications of the men who have had charge of its administration and of its various branches of instruction, have given it a most enviable reputation throughout the United States and beyond.

A great difficulty in agricultural education has been and is to devise some system by which the students of the college shall be educated in such a way as to send them back to the farm, instead of away from it. If the standard of education is lower than that of other institutions of college grade, farmers refuse, and rightly refuse, to subject their sons to that kind of disparaging comparison. On the other hand, if the standard is as high as that of other colleges, the graduate has in most cases a practical advantage from the fact that, in addition to his theoretical training in the knowledge and application of principles, he has acquired some familiarity with practical methods of work, which supersedes the necessity of a long apprenticeship. But this may naturally lead him away from the farm; for, in addition to the proper training, a young man, in order to make profitable use of his education as a farmer, must either be the possessor of a farm, or of capital enough to purchase and equip one; since in the absence of that he can make better use of his acquirements than as a laborer on another's farm. The great majority of our college graduates are not fortunate enough to

own farms. They must turn themselves for a time, at least, to some employment which will give them a sure and prompt means of paying off their college debts, or helping to clear off a mortgage on the old homestead (which in many cases has been placed on it for the sole purpose of giving the promising boy a chance to make the most of himself), or getting together a little capital with which to make a start in life. Making allowance for special cases, they will, of course, seek and find employment in those branches of industry in which there is the greatest and most constant demand. Where will that be in Massachusetts? According to the census of 1890, 81,100 persons were engaged in agriculture, fisheries and mining in the State of Massachusetts, while 672,159 were engaged in trade and transportation and in manufacturing and mechanical industries. That is, 10.76 per cent of the industrial population were engaged in agriculture and 89.24 per cent in manufacturing employments; so that the young man in Massachusetts who sets out to seek employment finds practically nine openings in other directions to one in agriculture, leaving wholly out of view the additional openings in domestic and professional service.

Taking the New England States together, including Massachusetts, the percentage of those engaged in agriculture is nearly twice as great as in Massachusetts, being 21.04; so that the average New England boy, looking out for something to do, finds about four openings in other directions to one in agriculture. The proportion varies greatly, of course, in the different States, but in only one of them, Vermont, does the number engaged in agriculture exceed that engaged in the other employments. I cannot but think, therefore, with all due respect to the judgment of those who may differ from me, that an agricultural college, as such, is precluded, by the very nature of the case, from playing any great part in the education of those who intend to engage in the *actual work* of farming, especially in the industrial States. The name itself is a misnomer. The law of Congress granting the public lands on which these institutions were founded indicated their true purpose in the clearest and most comprehensive language. It declares that "the leading object

shall be, without excluding other scientific and classical studies and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, *in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life.*" These colleges were intended, therefore, to provide, at public expense, places in which the youth of the several States could secure a training which would fit them for leadership in the various industrial pursuits, rather than in the so-called learned professions, which were already provided for by existing institutions. If this original design were kept clearly in view in the courses of study provided, and some general designation adopted (like State College, for instance, which is used in Maine and a number of other States), young men would naturally seek and find there the kind of training pointed out by their individual aptitudes, or by the prevailing occupations in their respective States. And it should be especially observed that, while the law of Congress emphasizes this kind of training and makes it the leading object of the colleges thus provided for, it is equally careful to provide that no other branch of learning shall be excluded. In short, the law clearly recognizes the need of both a general and a technical education, and, in its whole spirit and purpose, aims to assist every aspiring, ambitious youth, especially those belonging to the industrial classes, in securing an education as sound, as thorough and as advanced as is procurable, at any cost, in the best institutions, and, at the same time, adapted to his special purposes in life.

Let me not be misunderstood. There will always be room and place for the best educated men on the farms, either as managing owners or as hired superintendents; and, accordingly, the agricultural college, whether bearing that distinctive name or a more general one, will have its necessary and honorable place in the educational system. But my point here is, that young men having their way to make in the world and needing a ready return in money will generally be able, in highly organized industrial communities like Massachusetts, to put their training to more profitable *immediate* use in some other industry than in agriculture.

This brings us to the question, then, whether any educa-

tional help for the future of agriculture is to be found, in addition to that afforded by the full agricultural college course. I am confident that there is such help readily available in several promising directions. A number of States are providing short courses of instruction, during the winter months, open to any farmer, young or old, without examination as to previous preparation and without exacting any standard of proficiency. Some use is made of books and periodicals, mostly by way of reference, but the instruction is mainly given in the form of plain, practical and suggestive lectures, treating directly of the principles and practice of intelligent farming, and accompanied with some elementary laboratory work in agricultural chemistry, botany, horticulture, etc. In at least one State, Minnesota, such courses have been made to extend progressively through three successive years. In several cases there have been established special courses in the principles of cattle feeding, dairy courses and courses for teaching creamerymen the science underlying their business. The instruction on practical topics is given, as a rule, by men who have themselves had successful practical experience in the subjects which they teach. The results of this kind of training have been, without exception, so far as I have ever heard, surprisingly gratifying. I have yet to meet the first one of these teachers who does not express his interest and surprise at the eagerness and success with which minds comparatively untrained to habits of study grasp and retain the essentials of their teaching. And, on the other hand, I have known instances in which employers felt themselves repaid, in a single year, for incurring the expense of sending a man to attend one of these special courses. This branch of educational work is comparatively recent, but there is abundant reason for believing that, with an increase of experience in conducting it and a better understanding of its possibilities on the part of the farming community, it will contribute very directly and powerfully to increase the profitableness of agriculture. In Pennsylvania a system of instruction is well under way, which aims to interest farmers and their families in systematic courses of home reading. The several courses are carefully outlined and a series of the best available books recom-

mended. Publishers are willing to furnish these books to such readers at a considerable reduction from the usual list price, and the instruction and examinations are given by correspondence. The number of such readers is already more than fifteen hundred, and is rapidly increasing.

But there is another means of agricultural education, or, more properly speaking, of education in agricultural communities, which, as it seems to me, might be and ought to be generally adopted, and which, if once put into successful operation, would have extremely important and far-reaching results. I mean the introduction into the rural schools of a careful, systematic, progressive and thoroughly competent teaching of the elementary facts of natural history and the elementary principles of the natural sciences. The children of these communities are constantly surrounded with the material conditions which form the basis of such instruction, but, for want of the simplest training in a habit of accurate observation, they grow up like the blind in the midst of a world of beauty or the deaf in the midst of a world of melody — Seeing, they perceive not; and hearing, they do not understand. I do not underestimate the importance and even the necessity of a knowledge of the "three R's;" but the most of that knowledge, after the first processes have been learned, can be acquired incidentally; and it seems to me nothing less than a wicked waste of time and an unpardonable wrong to the children that they should be compelled, winter after winter and summer after summer, to go through the varying stages of the same treadmill routine, at an age when their minds are hungering and thirsting for knowledge, when all their faculties are alert and eager with inquisitive curiosity, when their whole intellectual and moral being is more plastic to permanent impressions than at any later period of life, and when the world of animate and inanimate nature about them overflows with the means of satisfying their natural craving. I cannot dwell upon this topic, and I am well aware that it is beset with difficulties, — the greatest difficulty of all probably being the lack of properly equipped teachers. But when once the State makes up its mind that this kind of teaching shall be given, and is willing to pay its teachers in the elementary and district schools

the same rate of compensation that the required degree of preparation and experience would command in other callings, all difficulties will be not solved but put in the way of a prompt and satisfactory solution.

I would not have this kind of instruction take the place of other necessary subjects, but interweave and incorporate it with them. I would especially have the child's mind early familarized with the great masterpieces of literature which are among the most precious possessions of the race, and I would raise his sense of the beauty and attractiveness of rural life and rural homes, and kindle in his breast a noble pride and enthusiasm, by showing him that the greatest masters have always kept closest to the heart of nature. Such instruction and such influences, though mentioned here with special reference to the formation of a basis for the broadest and most advanced agricultural education, are equally desirable, nay, more, are indispensable as the sound basis of all education. I merely emphasize the fact that the natural surroundings of children in the rural communities give them an immense advantage to start with, whatever is to be their subsequent calling in life.

It may be interesting at this point, by way of illustration, to present a skeleton outline of the facilities provided by the French government for agricultural education in all its phases from the lowest to the highest. The statement has kindly been furnished to me by President Goodell of Amherst, translated from a recent French document: —

A true polytechnic school of agriculture; a national school of forestry; four secondary schools of sylviculture; three national schools of agriculture; three national veterinary schools; one national school of horticulture; one national dairy school; two national schools of agricultural industries; sixteen farm schools, intended for farmers and superintendents; forty-one agricultural orphan schools; two model sheepfolds; a school of horse breeding; fifty-one practical schools of agriculture, viticulture, drainage, irrigation, cheese making; a large number of professors of agriculture, whom you might term itinerant instructors; sixty-two agricultural stations and laboratories; several thousand fields of demonstration; twelve hundred subsidized associations;

eleven hundred and fifty syndicates, numbering more than five hundred thousand members. In addition to this public or official instruction, there is agricultural instruction given in institutions which are free: first, the school of the higher agricultural studies at Lille; second, the agricultural institute of Beauvais; third, the free school of agriculture and viticulture at Saint-Astier; fourth, the free school of agriculture of Providence in Aurons; a course of rural economy just established at Paris. In addition to this, in each of the departments of France there exist one or more agricultural orphan schools.

There is no formula for making every man successful in any calling. There is nowhere a perpetual insurance policy against failure. The farmer must take the same chances and stand the same tests as other men. Carefulness, intelligence, frugality and thrift will, in the absence of special calamity or disaster, invariably win success. Negligence, ignorance, wastefulness and laziness won't. In the perpetual shiftings of modern industry, the farmer has one advantage of which he can never be deprived. All improvements in machinery operate principally to reduce the margin between the cost of producing the raw material and the cost of converting it into usable commodities. All increased facilities for transportation reduce the margin between the cost of producing raw material and other commodities and their selling price to consumers in the market. The farmer secures the benefit of both of these reductions in the diminished cost of every article which he purchases; but the cost of the raw material which he produces is less subject than the finished product to variation from artificial causes, for the reason that human labor enters in larger proportion into the former than into the latter. In other words, the most constant, that is, invariable factor in production is human labor, and therefore the farmer will, in the long run, secure a larger and safer (that is, less variable) return for his product than any other producer; and there is always a market for good things. On the other hand, the farmer is at one disadvantage, which, in the very nature of things, he can never fully overcome; he is obliged to plan his expenditure and his income largely with refer-

ence to the operations of an entire year, as far as they relate to the cultivation of staple crops. His investment, so to speak, is made in the spring; his returns cannot be gathered until autumn; and, in the mean time, his best calculations and most wisely directed energies may fail of their expected reward, through variations in world-wide conditions respecting which he can have neither foreknowledge nor control, while other producers can, in a measure, adapt their operations to conditions as they change from day to day or month to month. But, as has been already pointed out, while the New England farmer can no longer reckon himself as an equally favored producer of those staples which are subject to world-wide competition, he has exceptional local advantages of his own, as the near neighbor of great industrial centres. He can produce apples of a quality and flavor not surpassed if equalled anywhere in the world, for the best of which there is always a demand at home and an increasing demand abroad. He can produce poultry and dairy products, for which there is a market the year round. He can by constant replacing and care keep up the standard of his orchards. He can raise an abundance of marketable hay. He can with sure though slow profit re-forest his woodlands and waste places with valuable kinds of timber, instead of leaving them to the chance of white birch and brambles. In very many localities he can, in addition to all these, supply towns and cities and summer resorts with small fruits, flowers and vegetables, according to the season. He can, it is to be hoped, under coming changes of legislation, once more raise wool at a profit, and exclude the direct underselling of neighbors who are ready to make use of our markets but unwilling to share in paying our taxes. And, while the returns for his laborious and exacting industry will not, in single instances, be so large and brilliant as those which come in exceptional cases to men engaged in other pursuits, I firmly believe that there is no other occupation in which a man possessing the qualities and exercising the virtues which I have named can, with an equal amount of capital, secure, on the average, so comfortable and happy a home for himself and his family, give his sons and daughters so good a start in life with a sound constitu-

tion and a good education, make for himself so honorable a place in the respect and confidence of his fellowmen, and complete so fully that measure of service which every man owes to the public as neighbor, citizen and patriot.

The Chairman. We have with us this afternoon a gentleman who knows New England and Massachusetts well, and I hope that he will be inclined to say a few words to us. I refer to the Hon. John E. Russell.

Hon. John E. Russell (of Leicester). I do not wish to be very backward in coming before the farmers of Massachusetts, especially now that I am out of politics. You may, those of you connected with agriculture, have noticed that for the last eight or nine years I have been absent from these meetings and from cattle shows; and I wish that that would be an example to others in politics to stay away, instead of making the farmers' meetings the vehicle for their ambitions. When I was secretary of the Board of Agriculture I used to plan to keep them out.

I am willing to say a few words this afternoon, although I had a feeling when I listened to Mr. Atherton that I would rather not speak, for the same reason that the colored minister at the south did not want to preach against chicken stealing, because he said if he did it would throw a coolness over the meeting. And so, after the enthusiastic presentation of the implied future of our farmers and the enormous growth of our manufactures, I am afraid that I cannot keep up with it all. He cites a political speech, I dare say, of the Hon. Mr. Boutwell, in which he showed the enormous increase of manufacturers at the door almost of every farm, and then proceeded to show the increase of farm productions between 1875 and 1885. There was no such increase. It shows somewhat the fallacy of what we have heard here this afternoon (excuse me, Mr. Atherton), and I will show you that Mr. Atherton may be misled. I speak with authority, because I assisted in making the census of 1885 on behalf of the farmers of Massachusetts. To show you how fallacious the comparison is, I may say that, whereas the production of corn largely fell off, the value of corn fodder largely increased; that, whereas the production of cereals largely fell

off, the value of the straw increased, — I will not give the per cent, but it was a very large amount; and that, whereas we did not have more than three-fourths as many cattle as we had ten years before, there was an increase in the value of cattle manure. How do you account for these things? I can explain it. The census for 1875 was wrong. It was incorrect. It did not take in the productions from the farm that ought to have been taken in. When we came to make our census of 1885, the census people of the time consulted the secretary of the Board of Agriculture. We concluded that we would rake this Commonwealth with a comb, so that not a straw would escape. We put in straw, corn fodder, manure, cider, vinegar, apples, large and small, cut flowers, the productions from cows and cattle kept in cities. One of the astonishing features is that two or three of the cities had the largest dairies of the State. I merely show that part of it, and I do not propose to go further in it. I merely put in that fallacy.

One more fallacy, sir. That is, that under some political change there would be an increase in the value and the product of wool. I wish to say here, and I am open to contradiction, that wool is not any cheaper to-day relatively than any other farm product, and, if it is increased by any act of law that cannot be applied to other farm products, it only means that 96 or 98 per cent of the farmers of the country shall be taxed more for their cloth in order that 3 or 4 per cent may have a higher price for this farm product, which after all is but a by-product. The average number of sheep kept on the farms in Ohio is only 35, and in Michigan, which is a large wool State, the average is not over 18 to the farm. I dislike talking politics. One thing I have always noticed is, when you talk about increasing people's taxes by protection, that that is not politics, but if you talk about lowering them, that is politics. I am talking as a farmer, not as a politician. This question of putting a higher duty upon wool is one of the rascalities that the farmers have got to be heard upon, because you cannot increase the value of other things.

The farms of Massachusetts are suffering. The best and most scientifically founded agriculture in the world is in the

British Islands. To-day the agriculture of England is in despair. There is scarcely a farm in England that is not in sight of some great manufacturing establishment. An enormous and prosperous industry is being carried on close to the farms. The agriculture of England is in the same difficulty that we are in in Massachusetts, owing to the competition that has sprung up on account of the difference and enormous change in methods of transportation. The opening of the Suez Canal, which connected the great western world with the Orient, has made the world one-half as large as it was formerly. Take, for instance, the Argentine Republic. Year before last that country, so distant from us that it seems almost to the south pole, produced 75,000,000 bushels of wheat, — almost as much, three-fourths as much, as the United States is called upon for the European trade annually. More than that; one of the smallest States this side of the Argentine Republic, the little republic of Uruguay, has come into the market with something like 10,000,000 bushels within four or five years, and they have but just begun. The fact that our farmers are to-day getting 81 cents a bushel for wheat, instead of 58 cents, as was the case six or eight weeks ago, is because of the partial failure in Argentina and also in the East Indies of the wheat crops. Up to and year before last the East Indies produced 35,000,000 to 50,000,000 of bushels of wheat a year, and that was made possible by the opening of the Suez Canal. The fact is, that the farmers of the United States have been brought into competition with people who live upon what we would call next to nothing. So far as the East Indies are concerned, the people live in huts, on earthen floors, with no furniture, and they subsist on a handful of rice; they work for 6, 7, 8 or 9 cents a day.

You can buy corn to-day, to be delivered next May, — what is called purchased futures, — in the market of Chicago for 26 cents a bushel. These are questions that the New England farmer has got to face. That he will be able to face them I have no doubt, because we have a large population. We have an active people, a fairly good agricultural climate, and a great deal better soil relatively than our people are inclined to think. We have a highly productive

soil. We have learned, for instance, how to grow corn, and learned it from the west. One of the members of the Board demonstrated a few years ago that a man could raise more than a hundred bushels of corn to the acre without a hoe going into that corn from the time it was planted until it was harvested; and more than that; since I was first secretary of the Board of Agriculture in 1880, we have learned the value of corn fodder so much so that we raise it to-day more as a forage plant than we do for the corn itself. I do not say that the farmers of Massachusetts have kept up relatively with the other industries of the State.

I wish Mr. Atherton, in giving the statistics between 1850 and 1890, had divided them up a little. I should have been better pleased if he had. In 1850 the value of the farms of this country was $3,271,575,000. In 1860, ten years later, the value had increased 103 per cent, and that was the increase you gave, sir, pretty nearly up to 1890. From 1870 to 1880 the increase was only a little over a million; not so much as the difference between the gold at which they were taken in 1860 and the paper at which they were taken in 1870. In 1860 (here is a point for we Massachusetts farmers) the State taxes were $94,186,746. In 1870 they had increased 98 per cent. Now, the increase of Massachusetts which is given as a proof of the improved condition of the farms, — isn't that largely due to the assessors? The farmers should not be taxed to give relief to two or three per cent of the people. This is manifested by the strong political feeling and discontent of the great body of men of this country, which statesmen would do well to heed.

That great statesman of the present age, the man who now in his old age can look back upon a powerful empire that he founded, from the place that he stands he looks up at the great colossus of the German government which his own hand reared, said the other day, in speaking of the United States, that the discontent of the great population was a matter that statesmen ought to heed. The business of this country rests upon farmers. Half of the people of this country to-day are engaged in agriculture or in handling agricultural products. More than 85 per cent of all our exports are the products of our farms. All this great busi-

ness that we talk about and brag about is the superstructure that rests upon the foundation of agriculture. Let it be remembered by statesmen, let it be remembered by those who teach the people, who call them together to listen, — let it be remembered that the foundation of any prosperity must be stable.

Let it be remembered that the farmers even here in Massachusetts are discontented with their local and State tax, even without going to the question of the great burden of federal taxation, which is borne solely, let me repeat it, *solely* by the agricultural population of the country.

Excuse me for taking up so much time.

President ATHERTON. I think I am entitled to the thanks of the Board for saying what should call out so eloquent a speech as we have listened to. I have listened with very great interest to the remarks Mr. Russell has made. I do not rise to discuss the question.

In the first place, the article from Ex-Governor Boutwell was an article printed in either the "Forum" or the "Atlantic Monthly," and if it was a political speech it was not when I saw it. Mr. Boutwell makes one or two illustrations to prove his statements which I did not wish to bring in.

If the statistics which he quotes are misleading, I am not responsible for them. I quoted Ex-Governor Boutwell simply as confirming what I had been saying from my own inquiry, and the statistics which I used were from the United States census exclusively, so that any statistics that Ex-Governor Boutwell quoted from the misleading statistics of Massachusetts do not apply to what I had to say.

If I had known Mr. Russell was here I should have said what I did in regard to wool with a great deal more emphasis, for I should have known that it would have called out his most eloquent speech. I believe in it, and he does not. I understand that Mr. Russell has expounded his views before the farmers of Massachusetts before.

Mr. RUSSELL. Never did, sir, — never.

President ATHERTON. I do not feel that I am concerned with the discussion of a tariff question. I firmly believe that the suggestion that I made, to give the farmer an opportunity to raise his wool, is a sound suggestion, sus-

tained by sound logic; but, as I say, that was no part of my purpose.

I would like to say one other thing in regard to statistics. I made a long skip from 1850 to 1890. I did it for two or three reasons. I did not intend to exhaust the subject. I cited the statistics which would contain the most suggestive comparison. During the period from 1860 to 1870 everything was measured on the basis of the incomparable paper currency. From 1880 to 1890 there was a period of very great prosperity. The periods varied, and I did not feel that it was important to my purpose to indicate the variations, because they will occur in any business, and have occurred in agriculture especially. My only point now is to suggest to the gentlemen of the Board that I had no purpose in taking one set of statistics rather than another. The farmer has got to put brain against more material things, and has got to make these material things the servant of his brain and his intelligence, or else the farmer has got to be wiped out of existence. I do not believe the New England farmer is ready to go, — I do not believe he ought to go. I believe I have pointed out the direction in which he must go. He must meet these competitions by the training of himself and his children for a life of agriculture. He must get all the aid he can in his life of agriculture, and he must plant that down deep in his children's hearts. I want the farmer to look his conditions as squarely as he can in the face. If legislation is wrong, try to correct it. There is no power in our system that can stand against the united intelligence of the farmers. When they once make up their minds they are going to have a remedy, they will have it.

President H. H. Goodell (of Amherst). There is just one thing that I want to emphasize that President Atherton spoke about this afternoon. He read you that list of colleges, associations and asylums, all in the interests of agriculture. In Germany, in France, in Belgium, in Denmark, — everywhere you find them. They commence with the children in the primary grade and lead them up to the university. It is only, if I may be pardoned, that the children are "dyed in the wool" at the very beginning and led up in this way that has made agriculture what it is. One thing

more: not only do they have this system, but they have different things. For example, there are blacksmith schools, from which professors are sent out. And when do they give their instructions? On Sunday, after the people have been to their church and have their afternoons. They have itinerant professors in France and Germany, whose duty it is to go about into all the little different villages and give instruction, and they usually take the time when the people are free, so that it will not encroach upon their time.

One thing more: you take France, Germany and Belgium, little bits of places, and see what a system of agricultural schools they have. They have a great many such schools, and here in Massachusetts we have simply one. You take all the other States, and they have simply one college. You want to commence at the bottom and lead right up, and until you do it you will not get the best results from agricultural education.

What are they doing in Denmark? Their butter commands the very highest price. The governor has appointed certain persons whose business it is to give instruction in the line that you are going to hear about to-morrow. In Denmark, in England, in Ireland, they send out what they call their travelling dairy. It carries a dairy-maid, a professor and one or two assistants, and they travel around from place to place to give practical instruction. I simply wanted to say this in continuation of what Mr. Atherton said.

Mr. Swift. In view of the fact that we have had this very interesting discussion, in which Mr. Russell led off and the speaker followed, and which came in consequence of Mr. Atherton saying "wool," I want to thank him now for saying "wool."

Mr. L. W. West (of Hadley). President Goodell has just spoken of farm life in Europe. A laboring man there gets a dollar a week wages How can anything compete with a dollar a week? Mr. Hamlin, the assistant secretary of the treasury, says a man in Japan gets ten cents a day and a woman five cents in some of their manufacturing establishments. How can anything compete with that? A Congressman from Connecticut says that 95 per cent of the

goods consumed in this country are manufactured in this country; and forty or fifty years ago he would say that 95 per cent were manufactured abroad. That shows that the protection we have had has helped us along. I am in hopes under the next administration that the thing is to be changed about; that we are to start where we left off in 1892, and go ahead. I think we are on the proper line. Let us use it the best we may; let us put brains into it, if we have them, and put in energy. Talk about blacksmiths in Europe. There they do not expect to shoe over four horses a day; here we expect to shoe ten. A Polander at home will lie still six weeks and do nothing, — be sick; but come to America, they work every day in the year and are never sick.

Mr. Russell. What is the difference between the price of wool now and the price in 1892?

Mr. West. It is worth about half as much now as in 1892. Of course the United States going out of the business has encouraged all the nations of the earth to increase their wool product, because they were going to have the American market. You may ask a Boston dealer what proportion of the wool cloths sold in Boston are now manufactured abroad, and he would tell you a large per cent. You ask him what per cent under the McKinley law were manufactured abroad, and he would tell you a very much smaller per cent.

Mr. Russell. Mr. West has given the idea that the farmers can grow rich by increasing their taxes. That is what I understand.

Mr. West. No; I did not say that.

Mr. Russell. The farmer pays all the taxes, gentlemen.

Mr. West. He pays more than his share.

Mr. Russell. He pays all the federal taxes, because they are on consumption, and every man except the farmer can shift his taxes onto some one else. The lawyer can charge a little more to his client for lying awake nights and thinking about his case. A doctor can add a visit or two to your bill when you are sick. The merchant can add to his profits. And the farmer is the man upon whom ultimately all taxes must fall. He has to buy at retail and sell at wholesale, and

sell in competition with the markets of the world without any protection.

The first agricultural meeting that I ever attended was in the town of Hingham. My friend Hersey invited me to make my first appearance with fear and trembling before that intelligent body of Massachusetts farmers. There was present there, with several other of the best speakers of this Commonwealth, a clergyman from Boston, the Rev. B. A. Carpenter, and he opened his speech with something that I have never forgotten. He spoke of a sign in the southern part of England, beginning with the king, "I govern all:" next the soldier, "I fight for all:" next the clergyman, "I pray for all;" next the lawyer, "I plead for all;" next the farmer, "I pay for all." I never forgot that. I do not think I have ever repeated it, but it has often been in my mind. That was, I think, the whole question of political economy put into small compass.

The business of this country, gentlemen, for the last four or five years, or five or six years, has been afflicted in all the paltry operations and all the great affairs of mankind. If you tell a western farmer that the reason why he did not get his price for wheat was because somebody was president or somebody was governor in place of somebody else, you would be only making a fool of him. You cannot make a fool of a western man that way. The fact is, that the price of the agriculture of our western country is fixed in the foreign markets. Why we have to-day a rise in the price of cereals, especially of wheat, is because they have had one of those great famines in India that they have every ten or twelve years, probably from time immemorial. The price of wheat has gone up from 58 cents a bushel, early in September, to 82 cents.

I am trying to induce these farmers to get their living by intelligence and hard work, not by taxing somebody else to get something for themselves; not call to Hercules when your wagon gets stuck in the mud, but put your shoulder to the wheel and boost it out. The price of corn is now low. Why? Because this country has raised this year more than 3,000,000,000 bushels of corn. Figure up what that is worth when it gets into the market of the world.

Corn is never purchased by the world except when wheat is scarce, for wheat will always have the preference for bread over corn. That corn is worth to the people of this country more than $700,000,000. The crop of corn has added to the wealth of this country in ninety days, — for it is a ninety-day crop from the time it is planted until it is harvested, — the farmers of this country have added to the actual wealth of the country, by one crop alone, more than $700,000,000. And, gentlemen, in reference to such a paltry idea as that the fortune of the farmers is controlled by government or controlled by law, look at the fact that two years ago the fall in the price of cotton reduced the value of cotton more than $50,000,000 in one year, and that loss fell upon the poorest people in the world. You ask, Who are the poorest people in the world? Not those Japanese. Not those Poles. Not the paupers of Europe, who are instructed in blacksmithing and butter making and farming. There are 8,000,000 people, citizens of this country, — just as much citizens as we are, — the blacks of the south, who are engaged in the cultivation of cotton. They are the poorest people in the world. Some 8,000,000 people in this country (and I am sorry to say it) are engaged in agriculture, and not protected. These people are the poorest, the most docile, the most unprotected and, I fear, the most hopelessly situated people of the world. Would you add to their burden? Whatever burden you add to agriculture you bring upon the poorest people that depend upon the product of the soil for their living.

Mr. West. The gentleman just up has spoken about the great exportations. If I remember rightly, 90 per cent of the products of the farms, excluding cotton, are consumed at home. We only export the surplus. This wool industry is of great importance to our country, and it should be encouraged. Supposing everything is so cheap in our market, as the gentleman seems to intimate it ought to be, how are we coming out? Where are we going to get the money to pay these taxes? It does not make so much difference what the taxes are, but let us have something to pay them with. That is what we want, as farmers.

The Chairman. I am requested to give notice that the

banquet extended by the Greenfield Club will be at the Mansion House, and the tickets are on sale for the public generally at the Mansion House office. I am also requested to say that to-morrow morning the Board meets at 9.30. The meeting is now adjourned.

Adjourned at 4.50 P.M.

On Wednesday evening a reception and banquet was given to the Board of Agriculture by the Greenfield Club, at the Mansion House. After the banquet speeches were made by President H. H. GOODELL, Hon. JOHN E. RUSSELL and others. There was fine singing by a male quartette. It was a well-planned and enjoyable occasion, and will be long remembered by all who participated.

THIRD DAY.

The meeting was called to order by Secretary SESSIONS, who said: The beauties of the town of Greenfield have a great attraction for many of our people, and I fear the ride they have taken this morning will be extended so that they will be a little late in coming.

If we have a report of the expert judges, we must have it this morning, and we must therefore call the meeting to order without further delay.

Chairman GRINNELL. Gentlemen of the Board: We are favored again with a most beautiful morning, and it is so beautiful that a good many of our members are away. We want to hear a few words from Mr. HARRIS, the expert judge, who probably will give us information and suggestions that will be very valuable. He will occupy a short time.

The meeting will be presided over by Mr. HORTON, and when Mr. HARRIS has concluded his remarks the lecture of the forenoon will be by the speaker for the occasion, Maj. HENRY E. ALVORD of the United States Dairy Division, one of our own friends and townsmen, and one who was most prominent in making arrangements and preparations for that great butter show which we had in 1879, which many of you will remember. At that meeting we had one of the largest collections of butter and dairy implements that had ever been shown in New England; and I believe the members of the Board used to say that that meeting gave a greater impetus to dairy work than anything previously done in the State. Conditions have changed. We have advanced. We have kept up the interest in the dairy, and we are now, here in Massachusetts, following what is to us, and perhaps all New England, the most important branch of our agriculture, and it is important for us to keep it still to the front. Our butter is consumed largely in our own country, and it is very important for us to keep our dairy business, our butter, cream and milk production, in high condition, and I think we are doing it. I think we shall. Mr. HARRIS of Boston, who has been examining our butter, will make a short report, and some remarks and suggestions

as to the quality of butter, how to put it up, how to sell it, and what good butter is.

Mr. E. A. HARRIS (of Boston). Mr. Chairman, ladies and gentlemen: I think I am unable to fulfil all the requirements of the chairman. I never made a pound of butter myself, so I do not think I can give you much information as to the manufacture of it.

Three years ago, in Great Barrington, it was my privilege to see a State exhibit of butter, and I was disappointed in the quality of the butter displayed. I am very much pleased with the display of butter here to-day, on account of its excellent quality. It averages very high indeed for this season of the year. It reflects great credit upon the exhibitors. It would stand creditably with the butter of any State in the Union. It has been my privilege to examine butter in various States. Vermont for many years has taken the lead of the United States. Although the exhibit to-day is small in quantity, it compares very favorably with any exhibit in Vermont in the winter season. The highest score was 97¾. Two years ago, in Burlington, Vt., the butter on which the gold medal was given scored 97½. Last year, in Vermont, I think the highest was 97 or 97½. I think Franklin County butter men are entitled to a great deal of credit. We now have the system of making butter throughout the year, so that new butter is placed on the tables of our customers every day in the year, and it is almost impossible to sell butter to the first-class trade unless freshly made. The newer the butter is, the better the customers are pleased with it. Great advances have been made in the last few years. Probably no article has been so improved as this article of butter. I claim there is nothing that comes three times a day onto the table that is so hard to get and so much of a luxury as really fine butter that has the flavor so much desired. I claim that butter making is an art, and the people who make good butter are entitled to great credit. The butter here to-day is, as a rule, put up in very attractive form. The trade has greatly changed during the past few years, and demands smaller quantities in smaller packages. They used to have it in large tubs, — June butter put up to sell in the winter; but we cannot sell it now to our trade. We have got to

have new butter. Therefore, the packages are smaller, and the number of five-pound boxes that are sold has quadrupled within the last five years.

A good deal of butter has been put into print, but print butter is on the decrease, because of the five-pound boxes. The flavor will depart more readily when in prints than when in a solid mass in five-pound boxes that can be closely covered. Large-sized families, clubs and hotels want it in larger quantities. The majority want it in very small quantities.

I will now give you the score of creamery and dairy butter: —

Creameries.

	Flavor.	Texture.	Color.	Salt.	Package.	Total.
1. Hillside, Windsor, Vt., .	42.50	25	15	10	5	97.50
2. Hinsdale, 1st premium, .	42.50	25	14.75	10	5	97.25
3. Hillside, Windsor, Vt., .	41	25	15	10	5	96
4. Shelburne Falls, 2d premium.	40.50	25	15	10	5	95.50
5. New Salem, 3d premium.	40.25	25	15	10	5	95.25
6. Chester, ...	40	25	15	10	5	95
7. Montague, . . .	40.50	25	14.50	10	5	95
8. Conway, ...	40	24	15	10	5	94
9. Northfield, . . .	39	25	15	10	5	94
10. Heath, ...	38	25	14.50	10	5	92.50
11. Amherst, . . .	38	25	14.25	10	5	92.25
12. Coldspring, . . .	37	25	15	10	5	92
13. Charlemont, . . .	34	25	15	10	5	89
14. Ipswich, ...	32	25	14	10	4	85
15. Ashfield,* . . .	–	–	–	–	–	–

* Received too late for scoring.

Private Dairies.

	Flavor.	Texture.	Color.	Salt.	Package.	Total.
L. F. and W. H. Gray, Ashfield, 1st premium.	43	25	14.75	10	5	97.75
H. C. Haskell, East Deerfield, 2d premium.	39	25	15	10	5	94
F. W. Trow,* Buckland, .	39	25	15	10	5	94
J. M. Harris, East Northfield, 3d premium.	39	25	14.75	10	5	93.75
Henry Lively, Hawley, .	40	25	14	10	4.5	93.50
C. A. Wiley, Buckland, .	40	24.5	14	10	5	93.50
H. W. Blair, North Blandford.	38	25	15	10	5	93
J. G. Pickett, Greenfield, .	38	25	14.75	10	5	92.75
Mrs. S. C. Severance, Leyden.	38	25	14	10	5	92
W. H. Laws, Fitchburg, .	37	25	15	10	5	92
C. A. Wiley, Buckland, .	37	25	14.50	10	5	91.50
D. H. Clark, Easthampton, .	36	25	14.75	10	5	90.75
C. B. Lyman, Southampton,	36	25	14.50	10	5	90.50
Winslow S. Lincoln, Worcester.	37	23.5	14.75	10	5	90.25
J. B. and H. H. Warriner, Hawley.	35	25	14.50	10	4.75	89.25
J. L. Brewer, Pelham, . .	33	25	15	10	5	88
Mrs. C. W. Hillman, Colrain,	32	25	15	10	5	87
H. H. Leach, ...	35	22	14	10	5	86
Francis Howland, Conway, .	30	25	15	10	5	85
C. A. Merriam, New Salem,	30	25	15	10	4	84

* Received after others were scored and premiums announced.

Some of these creameries have probably scored at different seasons a higher score than here to-day. A great many factors combine to determine the high flavor of butter. I presume there are cows in some of these creameries that have given milk for months. The longer the cow is in milk, the poorer the flavor of the butter. That, I think, accounts for

the low score of some of the creameries. Frosted grass is very injurious to the flavor; it will take off three, four or five points.

Mr. Gray (of Ashfield). You call 15 perfect in color. The butter that scored $97\frac{3}{4}$ you called $14\frac{3}{4}$ in color. I would like to ask if it would improve the butter to put in artificial coloring.

Mr. Harris. Mr. Gray is, I believe, the man who made that butter. I want to say that the family of Grays has made delicious butter for years. I have bought their butter and paid fifty cents a pound for it.

I was one of the judges of butter at the World's Fair; and the standard was established there that has been used, I think, throughout the country of having June color as the standard of color. It is an exceedingly difficult matter to have the judging of the color of butter entirely satisfactory. There are really no two samples exactly the same shade. I try to carry in my mind a shade nearly up to June butter. Although this butter was a little light colored, it would not hurt it for sale, but I could not mark it as perfect color.

Mr. Gray. My question was, would it improve the butter to put in artificial coloring?

Mr. Harris. I do not think you would get any more for your butter.

Mr. Gray. Would it improve the flavor?

Mr. Harris. Not at all.

Question. Is there any reason for believing that coloring will injure the flavor?

Mr. Harris. I have seen butter in which the flavor has been injured by coloring. The demand of the market should control. Every man who has a customer should please that customer, and not me. The man who pays the money is the one you want to suit.

Mr. ———. Thirty or forty years ago it was our plan to put up butter to please a certain firm, and we are keeping about that for a standard. We have heard a great deal about standards lately. I wish to know about the standard in butter to-day.

Mr. Harris. There is a great difference in customers. We have recently had quite a large and growing demand for

unsalted butter. This trade would not care if it was as white as paper. Another class of customers would not have it at all. So we have to have a variety of the same quality of butter, in order to suit different tastes.

Mr. Grinnell. Mr. Horton, who is a member of the Dairy Bureau of our State, will preside over this meeting to-day.

Mr. D. A. Horton (of Northampton). This is the dairy day of the winter meeting. It is so laid down in our programme. I believe the subject of dairying is of more importance than we usually think it is. A very prominent man of Iowa made a statement before the Farmers National Congress in regard to the dairy interests of the United States. He said: "If all the gold, silver and bonds of the country were sunk out of sight, in one year the cows or their products would more than balance the loss." So it seems that dairying is of no small account in the United States.

The first speaker we have this morning needs no introduction to this audience. It gives me great pleasure now to present to you Maj. Henry E. Alvord, chief of the dairy division, United States Department of Agriculture.

Major Alvord. Mr. President, members of the State Board, ladies and gentlemen: A friend said to me yesterday, "The person who took second premium here to-day took second premium at the former fair." But that man has made an advance. The second premium yesterday, yes, the third or the fourth man, had a higher grade of goods than the one who took the first premium awarded in this building seventeen years ago. If a person in the general advance holds the same rank, to use a common expression, he is certainly keeping up with the procession.

THE DAIRY INTERESTS OF THE UNITED STATES.

BY MAJ. HENRY E. ALVORD, CHIEF OF THE DAIRY DIVISION, U. S. DEPARTMENT OF AGRICULTURE.

Seventeen years ago to-day the State Board of Agriculture, at its last winter meeting held at this place, accorded me the honor of presenting some considerations upon "The dairy interests of Massachusetts." At the same time I had the pleasure of superintending the first butter show held by the Board in connection with its winter meeting. It is a great privilege to me to now return to my native town, and, in response to the courteous invitation of the same Board, contribute to another "dairy day" a similar paper, on the broader field of "The dairy interests of the United States."

Again the Board has chosen this famous butter-making county of Franklin as a suitable place for an exhibition illustrating the best dairy products of the Commonwealth. And a successful show it is, well patronized, well managed, with displays of high average quality, and altogether in several respects a truly noteworthy exhibit.

It seems appropriate on this occasion to compare the conditions under which dairying was carried on in New England and elsewhere at the time mentioned with those which now dominate this great industry in America, and endeavor to discover some practical ways for continuing in the future to a reasonable degree, the very rapid advances made in dairy husbandry during the last fifteen or twenty years.

The exhibition in the hall below, in December, 1879, was exclusively of farm dairy butter. There were one hundred and twenty-five entries of butter, nearly all made in this county, and the implements shown were all for use in facilitating the dairy work upon the private farm. There was

butter made by the old style of setting in small shallow pans, as well as by shallow setting in larger pans, with and without special arrangements for heating and cooling; and other samples from dairies where deep-setting of milk in tanks of cold water was practised, some in open cans, some closely covered and some submerged. All depended upon the natural method of creaming by gravity, or the "rising' of the cream, with a single exception. During the show there arrived about noon, by express from Southborough in Worcester county, seventy miles distant, well-made butter from that morning's milking; this was made possible by the centrifugal cream separator in use at Deerfoot Farm, — then the only machine of its kind operating in this country. That separator and its product were the wonder of the day. Six months before that time Dr. DeLaval of Sweden had exhibited his first dairy centrifuge in England.

Interest in improved cattle was then quite active in New England, but the blood of the Channel Island breeds had not become generally diffused, and was not so well recognized as now as the basis for the profitable butter-making herd. Butter was in our exhibit from the famous cow "Jersey Belle" of Scituate, whose record of six hundred pounds of butter in one year and seven hundred pounds in the next was then unprecedented. And our lamented friend, who contributed so much towards making and marketing choice butter in this State, sent samples from the pure Guernsey herd at Millwood Farm, admirably representing the characteristics of a breed then comparatively unknown in this country.

At that time the Whitings were making butter in New Hampshire from the surplus of their contract milk, and the Nortons in Connecticut were buying milk from neighbors, setting it in big shallow pans and crudely conducting a factory, without that name, to meet the growing market for their fine butter at Hartford. With these two inconspicuous exceptions, which nobody seemed inclined to imitate, there was not a creamery in existence east of the Hudson River. Creamery butter had become abundant in the Boston market, and its merits recognized. Creameries had then been in operation in New York for ten years, in Illinois nine

years and in Iowa eight years, and were increasing in those States. New England butter-makers knew something was the matter, but were groping about to find what had hit them. Within a year, however, the advantages of the creamery system and its adaptation to eastern wants, as set forth at the last Greenfield meeting of this Board, began to be appreciated, and the author of that paper succeeded in persuading a few enterprising farmers to organize in the neighboring town of Hatfield (1880) the first co-operative creamery or butter factory established in New England. In fact, the whole creamery movement in New England may be fairly said to date from that meeting here, in 1879.

Prior to 1880 our entire southern country and all territory west of the Missouri River was mainly supplied with butter and cheese from the eastern, middle and a few north-western States, the local dairy production being insignificant. The home supply of first-class butter was insufficient, and no accumulations of good grades for any length of time could be found in American markets. The country was then producing a surplus of cheese, its average quality was high and its foreign reputation of the best. The foremost authority of the United Kingdom wrote in 1878, after the British dairy show in London: "A few years ago no one thought for a moment that we (in Great Britain) had anything to fear from the quality, whatever we might have from the volume, of American competition in cheese; but now we are beaten all along the line."

We were at that time exporting about one hundred and fifteen million pounds of cheese annually, nearly all of it going to England. Ten years before, during the period of reciprocal trade relations with Canada, we had found a good market there, and sent millions of pounds of cheese across the St. Lawrence annually, to be consumed by the Canadians. In 1879 the repeal of the treaty had cut off that market, and the Canadians were not only making their own cheese, but beginning to export some; this trade did not then, however, interfere with that from the United States.

Fifteen to twenty years ago farmers were often advised to examine their cows, keep records of individual performance and weed out their herds. But daily weighing of the milk

yield and an occasional separate churning for every cow was the only method proposed as a substitute for pure guess-work, and no means were offered for detecting losses in creaming and churning, excepting expensive analyses of skim-milk and buttermilk.

A wonderful change has been wrought in the dairying of this country during the seventeen years which have passed since the State Board last met at Greenfield. The quality of our dairy stock has very rapidly improved. It is estimated that there are now three hundred and fifty thousand pure-bred dairy animals in the United States, and the blood has been so generally diffused that over one-fifth of all our cattle are grades. Herds of pure-bred cows and others practically pure in blood, although perhaps not registered, are now common, and there are numerous records of butter-making herds with a yearly average of three hundred to four hundred pounds. Several single animals are on record as yielding from eight hundred to one thousand pounds of butter a year, and these are not confined to one breed.

The extension of the creamery system of butter making has been remarkable. There are now but seven or eight States and Territories in which butter factories are not in operation, and the total number in the country is approximately ten thousand. Of these there are at least six hundred in New England and seventy of them are in Massachusetts. This extension has been largely due to the introduction of the separator system, or mechanical method of separating cream by centrifugal force. This one invention practically obliterates the limitations of butter making, due to climatic conditions, and butter factories can now be operated without ice about as well in Mississippi as in Maine or Minnesota. There are probably twenty-five thousand centrifugal cream separators now in use in this country, all introduced within fifteen years. When, for storage purposes or in the working rooms, in extremely warm weather, lower temperature is needed, the perfected refrigerating machines are introduced to advantage. These are so efficient and so cheap that creameries have in numerous cases adopted them in the north as well as in the south, in place of ice. Transportation facilities have also very greatly improved. All dairy

products are better provided for locally; where moved in quantity, and butter can be carried two thousand miles or more, and delivered in good condition, at considerably less than one cent a pound.

Meantime, a marked change has taken place in the condition of our domestic markets and in the movement of dairy products in this country. Recent personal examinations have shown me that several sections, recently depending upon being supplied from a distance, are now making most of the butter and cheese they use, all of it at times, and sometimes more or less to spare. The Pacific States, so lately large buyers from the east, have their dairy commissioners and State dairymen's associations, with numerous creameries and cheese factories, and not only buy little or no butter for themselves, but are shipping largely to the mountain States on the east, and seeking markets north, south and west, reached by water transportation on the Pacific. Not quite cheese enough is made in that region for the home demand, but the output is fast increasing. Utah supplies herself. Colorado does the same to a large degree, and sends supplies to neighbors north and south. Kansas, Nebraska and the two Dakotas have active dairy associations, and are producing more butter than they can use. Minnesota is becoming a great dairy State. At such points as St. Paul, Omaha and Kansas City, where a few years ago dairy products were constantly moving westward in large quantities, a surplus is now moving to the east. In most of the southern States creameries are being established, and at numerous points the local supply of butter, although small, is found sufficient. Cheese is not yet made in that region to any extent, but it is worthy of note, as indicating future possibilities, that a gold medal was awarded at the Atlanta exposition to cheese made in South Carolina, and some of it kept there a year or more, which good judges pronounced of the very highest quality.

As a result of these changed conditions, butter is coming to our large eastern markets in increasing quantities. Whether it be the result of over-production or under-consumption, we need not stop to consider. The fact remains that the stocks of stored butter in Chicago and at Atlantic

ports are uncommonly large, and there is appearing, at least at times, a surplus of butter of high grade. Exports are needed for relief, and more has been done in this line during the past year or so than ever before. But this has been made possible only by the extremely low prices which have prevailed. American butter has no fixed reputation abroad, and exports have never been regular enough to establish a foreign market. Under present conditions, and while our butter fails to compete abroad with the Danish and other high grades, it is only when the price of good butter falls below nineteen cents at New York and Boston that buyers for export are likely to appear, and as soon as creamery grades reach twenty cents this outlet appears to be closed. Much as butter exports are to be desired from our Atlantic and Pacific ports no such trade yet exists of a regular, reliable or satisfactory character, as to either quantity or quality.

Our foreign cheese trade is in even worse plight, because, having once been in a flourishing condition, it has been almost destroyed by senseless and shameful practices. Manufacturers and merchants, from avaricious motives, have sent abroad during the last few years large quantities of low-grade and counterfeit cheese, which has disgusted British buyers and ruined the former excellent reputation of our cheese. The result is that, instead of sending away half of our season's output to meet foreign demands, as was done for a time, we now find a market abroad for less than one-fourth of the yearly cheese product. This is particularly humiliating, because Canada has gained all we have lost. By confining her manufacture to strictly honest, full-cream cheese, constantly improving in quality, Canada has won the place formerly held in the British markets for cheese from the United States. She now exports annually as much as this country ever did, and our exports of cheese are less than those of Canada were sixteen or seventeen years ago. At the same time, our domestic markets in many parts of the country have been flooded with fraudulent cheese to such an extent that consumption has greatly decreased, and our home cheese trade has been generally demoralized. Extremely low prices have ruled for even the best product.

But since the recent law of Congress has gone into effect, which regulates the manufacture of filled cheese, confidence seems to be improving and our cheese market is now in a far more satisfactory condition.

The milk supply of our cities and towns is a branch of dairying which has been rapidly developing in recent years, and in some respects this business has been improved. On the whole, however, while continuing to increase in volume, the milk trade is conducted in an irrational and very wasteful manner, to the detriment of producer and consumer.

The magnitude of the dairy interests of the United States is not generally appreciated. Cows are familiar objects, and milk and butter are seen everywhere and used with reasonable freedom in almost every family. But few stop to consider the aggregate and relative value of the cow and her products in this country. In classifying the agricultural products of the United States according to value, butcher's meats and meat products take the first place, in gross value the corn crop comes next, the hay crop third and dairy products fourth; wheat, cotton and other staple crops then follow. But large parts of the corn and hay crops directly contribute to the dairy, and appear in market only as transformed into dairy products; making proper allowances on this account, it is found that the products of the dairy hold the second place on the list, exceeded in yearly value only by meats. This annual value of what may be called our dairy crop approximates $450,000,000. This is more than all our mining products, other than coal, oil and gas. Much has been heard lately of precious metals; it may be interesting to note that there never has been a year when the entire gold and silver product of *the world* was enough to buy the dairy products of this country the present year. The cows of California annually yield a greater value than the gold mines or the wheat fields of that great State. Our cotton crop is considered one of great importance, but during recent years it rarely exceeds our butter crop in value. It would require the entire issue of United States treasury notes (or "greenbacks"), or the entire issue of national bank notes, to buy the butter crop of the year, and these combined would be needed to purchase all the dairy products of the

country for the year. The total annual revenue of the government of the United States has not been enough in thirty years to buy the present yearly products of our cows. On the other hand, these products, at market rates, would pay off all the State and county debts in the nation and leave a handsome balance. These comparisons show that we are presenting a subject well worthy of consideration, and which has a commercial importance which fully justifies special provisions by the federal government and by the several States to advance its prosperity and guard its interests.

Let us now consider, as fully as time will permit, some of the reforms and improvements which the present condition of the dairy interests of the United States suggests as desirable, if not essential, to future welfare. These naturally group themselves under four heads: first, economy of production; second, increase in quality and variety of product, which should increase income; third, improvements in transportation and trade; and, fourth, extension of markets at home and abroad.

First. — When in any business the margin of profit becomes uncomfortably narrow, there are usually but two ways to improve, — either increase receipts or reduce expenses. The most hopeful direction for improving the business of the dairymen at the present time is manifestly in economy of production.

The first requisite in this line is to secure cattle suited to the object in view. In these days this is not a difficult matter. Dairy cattle of improved blood and specially adapted to different branches of dairying are fast increasing in number, and sell at prices within the reach of any enterprising farmer. The quality or breeding of dairy stock has not been separately ascertained, but it is known that in the neat cattle of the country as a whole between one and two per cent are pure-bred, and, as already stated, nearly if not quite twenty per cent, or one-fifth of all, are grades of one-half improved blood, or better. New England and the middle States lead with over two per cent pure-bred, but have only the average of the country in proportion of grades. The north central division or group of States, including Ohio, Kansas and North Dakota, have more than one-fourth of

their cattle improved and stand second in those pure-bred, with about 1½ per cent. It is probable that, on the whole, the degree of improvement is greater among dairy cattle than in beef stock. There is now little excuse for a dairyman who wants butter cows failing to have those specially adapted to this want through many generations of special breeding. And it has been conclusively demonstrated that the cow which is most profitable for butter making is also most profitable for producing the best cheese. There is no cheese cow, separate and distinct from others. Milk-producing cows, suited to general city supply, can also be easily found; but it is hoped that the time is at hand when the milk market will demand quality as well as quantity, and in advance of legal standards. Some dairymen are still searching for the "general-purpose cow;" these are to be pitied, for they are certain to be distanced in the race by their more enterprising neighbors, who are guided in their selection of stock by the best teachings of the time.

The health of the herd is of the utmost importance. All thoughtful observers must be ready to admit that the matter of providing warm and close stables for dairy cows, especially in New England and other States having long and severe winters, has been sadly overdone. To many good herds the result has been destructive. In far too many cases cows have been kept in dark, damp, close, basement stables. subjected to hygienic conditions worse than those attending the worst class of city tenement-houses, or even the slave pens of history. We should all welcome the era of pure air and sunlight. Away out in the State of Washington I lately found a statute requiring at least eight hundred cubic feet of air space for every stabled cow. This is a reasonable requirement, and to it might well be added the opportunity for sunshine to daily reach some part of every stall. The enterprising dairyman of to-day will see that the sanitary conditions to which his cows are subjected are as good as those of the house in which his family dwells. This sanitary reform should precede, or at least accompany, the measures taken by State or municipal authorities for eradicating contagious and infectious diseases which may be found in the herd. And these measures should be freed from the fads of

extremists and based upon the teachings of science and experience, which show that the public health may be properly guarded without violence to private rights or the summary destruction of the dairyman's herd, and sometimes of his business. This is not the time to enter upon a discussion of this subject, but I cannot refrain from briefly quoting from the authoritative and encouraging report of Professor Dr. Bang of the Royal Veterinary College of Denmark, on bovine tuberculosis, which has lately been translated and distributed by the Massachusetts State Board of Agriculture: —

I consider the requirement of killing the cattle reacting (to the tuberculin test) within a year's time as too rigorous, at least in countries in which cattle are chiefly held for milk production. The large majority of reacting animals are only slightly tuberculous. According to my observations, they can remain for years fully capable of accomplishing their work, and with many of them the tuberculosis probably remains wholly localized for the entire life, or even a cure may take place. Why, therefore, should the owner be required to butcher his best cows? In milk-producing countries it has long been attempted to establish a race of great milkers. In recent years particular attention has been paid to breeding only such cows as furnished milk with a high percentage of butter fat. It has been done because this most valuable quality seemed to be hereditary. Should the work thus accomplished be now destroyed? The requirement mentioned would mean for many cattle owners nothing less than financial ruin.

Dr. Bang then goes on, in this most valuable report, to show how, by proper precautions and rational procedure, a healthy herd may be built up on the foundation of one which has been technically pronounced diseased, although not what is ordinarily regarded as sick, — and this without prejudice to the public health.

Rational feeding of cows offers one of the best opportunities for the exercise of economy now open to the dairyman. So much has been already said and written upon this subject, and so much good work is still going on, — all made available to those who seek it, — that nothing more than this reference is necessary here. Economy demands of every feeder an intelligent study of the materials he has at hand,

and those which he can profitably use as supplements, with their combinations. This involves familiarity with the current market prices for feeding stuffs. It often happens that a farmer, whose first thought is to use the crops produced at home, can sell hay and grain, and buy certain forms of concentrated cattle food which happen to be available at advantageous rates, — gaining material profit by the exchange. It was lately well demonstrated to dairymen in the northwest that they could not only afford to sell corn at sixteen cents per bushel and oats at fourteen cents and buy wheat bran to feed instead (at $4.50 per ton), but that a handsome margin of profit attended such transactions, besides providing a better-balanced ration for their cows. The selection of cows and the feeding problem have been well managed at the Minnesota Agricultural Experiment Station. I lately examined there the animals, the feed and the daily records for two years, which show several cows producing butter month after month at a cost for food of only four cents per pound, and sometimes less. Other cows, which would generally pass for good dairy stock, fed on the same materials, made the food cost of the butter produced two or three times as much. At the low prices of feed which prevail this winter, the station mentioned is able to carry good dairy cows of one thousand pounds' weight on a daily ration costing from four to five cents. This same station finds "a cow will do her best on a balanced ration composed of any of the ordinary feed stuffs, provided they are palatable and digestible." This being the case, the judicious feeder will select the cheapest available food that will make a ration meeting the conditions named.

The figures given as the cost of producing butter from a good cow in the State of Minnesota show the competition which butter-makers farther east must meet from that section. It is stoutly maintained that, proper allowance being made for all expenses, Minnesota can place good butter in our eastern markets at a total cost of ten cents a pound, or twelve at the most. As contrasted with this, the dairy department of Cornell University (New York) reports sixteen cents as its lowest figures for food cost of producing a pound of butter fat. This means a cost of over twenty cents for

butter ready for market. Our eastern dairymen must do better than these Empire State leaders, or else do business at a loss.

The daily care of cattle and especially the operation of milking furnish further fields for the exercise of economy in management. Proof is abundant of the direct profit of a kind, quiet, clean and considerate care-taker and milker; the cow responds generously to the person in whom she thoroughly confides, by increase in both quantity and quality of milk. A careless, rough, rude handler and milker, or one uncleanly in person or habits, is dear at any price. Most of the taints and early changes in milk and injury to quality of its products can be directly traced to carelessness in the surroundings and condition of the cow or her milker at the time of milking. I have lately been at once astonished and disgusted at witnessing the milking of large herds of cows in some parts of this country by foreign milkers who practice the wet method, — frequently dipping their fingers in the milk pail. This impressed me more than ever with the urgent need of a cleanly, efficient and economical substitute for hand milking. The much-desired invention seems to be nearer than ever before. Some hundreds of cows in this country are now regularly milked by machinery, and have been for months, with apparent satisfaction to the cows and their owners. It looks as if the successful mechanical cow milker was at last in sight.

In the care and manipulation of milk and cream there is no excuse for the losses which have prevailed in the past, and been mainly unknown. Our modern methods of preventing deterioration, of determining and regulating acidity and ripeness, and of applying tests to discover losses in creaming and churning, are too familiar to call for further remark. We should recollect, however, that for most of these aids to economy we have to thank the very practical work of our scientific friends at the experiment stations and the dairy schools.

There is great need for a better utilization of the skim-milk and buttermilk of creameries and private dairies. The profits of modern manufacturers often depend upon skill and economy in disposing of the waste products. Dairymen may

profit by these examples. In some localities a very satisfactory market has been built up for skim-milk and buttermilk sales for household use. But vast quantities of these waste products in creamery districts still yield next to nothing. It should not be forgotten that the components of skim-milk give it a relative fertilizer value of about ten cents per hundred-weight, for the compost heap, or direct application to crops. A careful feeder should realize at least twenty-five cents per hundred-weight for skim-milk, and about as much for good buttermilk, as food for any young growing animals, including poultry. Experimental evidence favors swine as utilizing these articles to a better advantage than other domestic animals. But skim-milk is worth at least half a cent a pound (fifty cents per hundred-weight) for family use, when compared with other food products of the farm. Sales to town and city housekeepers can be urged on the ground that skim-milk at a cent a pound, or about two cents a quart, is cheaper, upon the basis of actual nutritive value, than any other article of animal food obtainable, even at the prevailing low prices. If properly used, householders can well afford to pay ten cents a gallon and even three cents a quart for sound, separator skim-milk from creameries and dairies. The use of skim-milk by bakers and in domestic baking should be greatly increased; a loaf of skim-milk bread is more nutritious and more easily digested than one made of water. Creameries and dairymen connected with agricultural fairs will do well to cause special premiums to be offered for skim-milk bread. It would be a public blessing to have an abundance of skim-milk on sale, at the prices stated, in all our towns and cities. Public opinion should be brought to bear upon the misguided municipal officials, who, in a few large cities, still absolutely prohibit the sale of this cheap and desirable article of human food.

Creamery management offers opportunity for material improvement in the interest of economy, and which, being effected, should increase the dividends to patrons or the price of milk. The greatest present waste is in the hauling of milk from the farms to the creameries or separating stations. This is a sort of indirect taxation, which it is difficult to express in figures. But the time lost by teams and

drivers, including delays in waiting one's turn at the separator and the incidental wear and tear of wagons and harness, must be very great in the aggregate, and this all falls on the milk producer. Efforts should be made to shorten these hauls, and neighbors should co-operate in the hauling. In like manner the hauling of cream to the gathered cream factories often costs too much, and needs study and saving. One improvement which has been adopted by some is to pay for gathering upon the basis of butter represented by the cream, rather than by cream volume or weight. The exact cost of butter is thus known, and in some cases it may be fair to charge the patrons on one route more than those on another, because of the difference in expense of gathering. Our creamery practice will not be upon a footing satisfactory to the producer until cream alone leaves the farm, and this is recognized as a commercial raw material, to be separated or "raised" by any method convenient to the farmer, sent away when or as often as the owner desires (so long as it remains sound), shipped in the most convenient and economical manner to any creamery preferred, and there sampled, tested and paid for according to its condition, quality and butter value, in the same way one would sell a load of grain or a lot of wool. The cost of making a pound of butter is still too great at most of our creameries. With butter at forty cents a pound, four cents for making and selling did not seem exorbitant, although a ten per cent tax on the selling price; but with the latter reduced to twenty cents and less, the cost of manufacture, remaining the same, absorbs twenty per cent or more of the gross receipts. This is a problem which should be vigorously attacked by creamery managers. At first glance it is hard to see how this cost of manufacture can be much reduced except by greatly increasing the quantity of butter made at one place. If that be the best solution of the difficulty, let us accept it and act accordingly.

Seventeen years ago I advocated the union and co-operation of butter producers in New England and the east generally, under the creamery system, as a matter of economy, efficiency and general progress in dairying. I am now prepared to advocate co-operation among creameries themselves,

and consolidation where practicable. The same arguments which were used in favor of having a number of butter-making farmers associated in their work may be applied to a group of neighboring creameries. Economy of administration and improvement in sales may be gained by hearty, harmonious and systematic co-operation, while the creameries remain distinct. But the advantages in making and selling greatly favor large producing creameries rather than small ones. In many cases it is desirable that complete business consolidation should take place. If fifteen, twenty or more creameries, co-operative or proprietary, are well situated as to means of transportation, etc., it will be to the interest of all concerned for them to unite in one company, transfer all butter and cheese manufacture to one point, and use the vacated buildings as separating stations, or sell them. The Franklin County Creamery in Vermont is an example worthy of imitation. The first creamery in that county was started in 1880; five years later there were thirteen; in 1890 these thirteen creameries, having then 34 separating stations, consolidated, and seventy-one such stations are now operated in that county by the one company, the cream from twenty-five thousand to thirty thousand cows being brought to St. Albans, mainly by rail, and manufactured under one roof, where eight or ten tons of butter are made daily. This creamery makes about three million pounds of butter a year. The economy of manufacture and the advantage in making sales need no argument. The same conditions must prevail as in the case of a single co-operative creamery, although perhaps in higher degree. There must be cordial concert of action among all concerned, and thorough efficiency in management, showing business capacity commensurate with the business itself.

There is another matter connected with creamery management which may be mentioned here, although somewhat out of place. The factory which in these days pays for milk or cream upon weight or measure alone is sadly behind the times. The true basis for settlement with patrons, whether butter or cheese is to be made, is the fat test of every lot of milk or cream received. But this fat test is not the easy matter often represented. The Babcock machine, or its

substitute in its simplest form, is a delicate instrument, which should be used only by a competent operator. Hundreds of these testers are in the hands of incompetents, and the patience of patrons under the injustice and many errors that occur is really surprising. The fat test is, after all, a sort of modified or simplified chemical analysis, and it requires a degree of the knowledge of principles, materials and processes, and of the skill and accuracy of manipulation, which belong to laboratory methods. There can be no objection to any one using a Babcock test, self-taught, for testing his own cows or dairy operations at home; the probable errors will not vitiate his results or defeat his main object. But I believe every man who uses a tester as the basis for commercial settlements should be proved competent by an examination, and should hold a regular permit or license, like a druggist's clerk. A law in the State of Maine compels all such operators or testers to be examined and certified at the dairy school of the State college. This is an entirely reasonable requirement, and deserves to be adopted in other States. A creamery which is not certain of having an expert tester is quite as likely to go right on the old plan of equal "spaces" or weights.

In this same connection it may be remarked that much of the glassware furnished with the cheap patterns of the Babcock tester is very unreliable, and is liable to give wrong readings, like the cheap thermometer. Considerable money transactions depend upon the accuracy of these little glass bottles and measures. They should be subject to inspection by a law, like other weights and measures used in trade. Every such piece of glassware should be examined, tested for accuracy and certified to before used at a creamery for settlement. An Iowa law requires this work to be done by the State Dairy Commissioner, and in Maine a similar law is executed by the State Experiment Station. These are also good examples to be followed.

Second. — It is believed that much can be done to advance the general condition of dairying and the returns to producers by improving the quality and giving greater variety to the products of the dairy.

Improvement in quality must come from the direct in-

struction of individual dairymen and creamery patrons in correct principles and better methods. Every creamery and cheese factory should be an educating centre and impulse. The work of such a concern, in the advancement of its own material interests, is but partly done if it does not exert a direct influence for good among its patrons. The factory management should distribute dairy literature, aid institutes or conduct meetings of its own, and not rest content unless there is perceptible an improvement in its product year by year, due not only to factory methods but to more intelligent and better work on the part of the patrons. The consolidation of creameries, as already noted, tends to increase the quality of average product of the community thus served. If the creameries are utilized in this way, as they may be, it is quite practicable to reach nearly all the dairy farmers tributary to them in the interest of improvement. It is much more difficult, however, to reach the private or farm dairies, and these still produce at least three-fourths of all our butter, although making comparatively little cheese. Abundant and most desirable work here presents itself for the dairy schools and farmers' institutes, for such agencies as can be provided by this Board and its Dairy Bureau, for the betterment of farm dairy products. From these farm dairies come the immense quantities of poorly made, low-grade butter, which crowd our markets, depress prices and injure the whole trade. The butter comes from fair cows and good feed; it is bad because its makers are ignorant of the principles and methods of handling milk and making butter. Is this not a legitimate field for educational effort by the States? New York has already done good work in this line, through the regular employment of five expert butter and cheese makers, who labor as instructors among the creameries, cheese factories and farm dairies of the State, In Wisconsin and Minnesota similar duties are performed by assistants to the State Dairy Commissioners. Canada affords a still more conspicuous example of the possibility of improvement by public training; the Dominion has a well-trained corps of instructors, operating under Dairy Commissioner Robertson, and they have brought about a wonderful improvement in quality and uniformity in the

present products of butter and cheese in the Provinces under their leadership.

Objection will be made that this proposition is decidedly "paternal." But it is no more so than the high schools and free colleges for professional students and the night schools for mechanics. It would simply be providing for a large class of people improvement which it seems impossible for them to do for themselves, and which, being accomplished, contributes to the public welfare. In some communities which I have visited within a year such dairy instruction by the State might fairly be compared with public philanthropy in aid of the deaf and blind.

Competent instructors are not wanting, and the service need not be costly. Besides the good men being turned out by the dairy schools in several States, I now have in mind as available, two well-educated Danes, skilled graduates from the dairy schools of their native country, a Swiss who had a similar training and was director of a dairy experiment station at Lausanne, and one of the best English authorities on cheese, author of standard dairy books and a successful manager of factories. All these men are in this country, occupied as butter and cheese makers in comparatively obscure places, and their services and talents ought to be exercised in broader fields of labor.

The more general preparation of small family packages of butter and cheese, and their use in the retail trade, is much to be desired. A beginning has been made in this direction, but much more is needed. For butter, a rectangular block or brick-shaped box or other package will be an improvement upon the round tub and box, in several ways. Still greater opportunities exist for increasing the varieties and styles of cheese placed upon the market. Proper effort will produce as great a variety of cheese in this country as is to be found in Europe; enough has already been done to show the possibilities in this line. The tendency of such variety will be to increase the use of cheese as food, and this is an object of real importance to the whole dairy interest of the country. The regulation kind of American factory cheese, usually called cheddar, formerly weighing from forty to sixty pounds per cheese, is now made in small sizes to some ex-

tent, but not nearly enough. (The dairy division of the United States department of agriculture has published a good deal on this subject of cheese, and the variety in kind and form which is possible and desirable in this country. These circulars and bulletins will be furnished to applicants until the supply is exhausted.)

The town and city milk trade also admits of improvement and greater variety to the advantage of buyer and seller. The appearance of establishments offering milk prepared or "modified" in various ways, according to the prescription of physicians or the special wants and orders of customers, of pasteurized milk and of milk "certified" or "guaranteed" as to purity and quality, is a departure in the nature of progress, and should be commended and encouraged. While some State supervision and municipal inspection seem desirable, under present conditions, I believe that the best promise for improvement in our milk supply lies in these up-to-date private enterprises. A good many of us learned long ago that, notwithstanding the regulations and precautions of associations and herd books, the best part of a pedigree was the name of the breeder. So, in the present effort to secure pure milk, I believe the safest reliance is the reputation of the producer and dealer. There is room for more of this desirable variation in the milk business and the subject will be presently mentioned again.

Third. — Attention needs to be given to improvement in connection with transportation of dairy products and dairy trade. Experience shows that improved facilities for moving butter and cheese by rail can generally be obtained on demand where the volume of products moved is sufficient to base the claim upon; and this is also true of milk. But experience has also taught that such facilities come much sooner when organizations of dairymen or State officials representing the dairy interests exert themselves to procure these accommodations where needed. Therefore, as soon as the need appears in any locality, action should be prompt and energetic to obtain the desired relief.

The old question of the short haul *versus* the long haul remains but partially and unsatisfactorily settled. If the Interstate Commerce Commission and the act of Congress

under which it operates can be brought to accomplish the object originally designed, some advantage in rates of transportation for perishable products ought to be secured to the owners of high-priced and heavily taxed farming lands, comparatively near our large markets, over the products of farms much more remote. But this result is hardly likely to be obtained without a combination of eastern farmers interested, strong enough to sustain a long, expensive and hard-fought contest.

The discrimination against milk and the unduly high rates charged by most of the railroads carrying milk to New York has led to united action on the part of milk producers shipping to that market; and they deserve high praise for bringing the subject before the Interstate Commerce Commission, and bearing the heavy expense of presenting an admirably prepared case, supported by a mass of testimony which seems to be unanswerable. The decision has not yet been made, partly because of this mass of testimony and partly because of the gravity and far-reaching application of the questions involved.

The railroad charges for transporting milk to nearly all our large cities are out of all reasonable proportion to the value of the commodity and the actual cost of the service rendered. The charges are more than the traffic will bear. They are excessive and unjust. Unless this important decision, when rendered, brings the desired relief the subject must be still further agitated, and the demand for abatement must be steadily and vigorously pressed to an ultimate and favorable issue.

More unreasonable and even absurd is the custom of charging for carrying over the same route more for a can of cream than for a can of milk. The cost of service is practically the same; if there is any real difference it is in favor of the cream which weighs rather less per gallon than milk. The carriers assume no responsibility for loss or damage in either case, and seldom furnish ice or refrigeration; but if they did, both being properly prepared, the cream will bear transportation the better, with less liability to injury, and it needs less refrigeration than milk. This matter of reasonable freight rates for cream is of growing importance, as the

practice of sending this article considerable distances by rail to creameries is becoming more and more common, and likely to rapidly increase. These expenses incident to the dairy business must be reduced at all possible points, and the whole subject of transportation of milk and cream, butter and cheese, in all ways and in all places, needs mature consideration and the earnest efforts of all parties concerned.

In like manner earnest work is needed to improve the trade in all dairy products. The expediency of multiplying small and attractive packages of both butter and cheese, in order to suit the taste and convenience of consumers as well as of retail dealers, has already been mentioned. The shape of packages has a bearing on economy in transportation and storage and in cutting up for retail trade. Popular taste and prejudice are slow to change, but yield to convenience and common sense. The brick-shaped "print" has largely displaced the roll and round "pat" of butter, for manifest reasons. The six-sided box is the coming shape for butter packages, for domestic trade as well as for export, for similar reasons. The same general shape may be profitably adopted for cheese. The necessity for cutting in the retail cheese trade should be avoided as much as possible by small sizes and fancy packages, and, for economy in sub-division, square cheese have already been used enough to prove decidedly advantageous.

Some new provisions seemed to be called for in trade, and possibly legal requirements will be necessary to create a more distinct classification in dairy products, and enable the average buyer to discriminate better as to quality or grade than he is now able to do. The old saying that "appearances are deceitful," is particularly applicable in our dairy markets. Much good has been accomplished in the prevention of imposition and fraud by the national and State laws now in force applicable to products of the dairy, but opportunities still remain for deceiving purchasers in the wholesale trade as well as the retail.

Where existing laws are properly enforced, oleomargarine and butterine are so well identified and their sale so well guarded that it is difficult to impose upon buyers by substituting these articles for genuine butter. But the whole

line of goods known to the trade as "ladles" are everywhere sold without restriction, mixed in with pure farm dairy and creamery butter. Under the deceptive title of "imitation creamery," much of this stuff is worked onto retailers without distinguishing marks, and sold to the consumer as fresh creamery butter. Ladled butter is not as deserving of place among straight dairy products as good butterine. The component parts of the former do not begin to be as cleanly as that of the latter. It may usually be justly claimed to contain only butter fat, but this must be described as purified, rather than pure. The promiscuous lots of poor farm butter which reach country storekeepers in trade and unfit for local sales are indiscriminately dumped into some convenient receptacle and absolutely neglected, being often exposed to contamination in various ways, and finally, when the package is filled, or its contents become so offensive that it cannot be longer endured, it is sent as slow, cheap freight, to the establishment of the "ladler." These packages of grease, which by no stretch of courtesy can be fairly called butter, often arrive at the factory, especially in warm weather, in an indescribably corrupt and disgusting condition. The material is then managed in various ways, as the processes differ, but usually it is melted up, "rendered" like low-grade lard, clarified, treated with chemicals to remove the vile odors and tastes, and then cooled, recrystalized as well as is possible, and churned with a little new milk or buttermilk, to restore something of the long-lost butter flavor. The resulting product is the "ladled butter" of commerce, and, if it happens to turn out a little better or more deceptive than the average, it takes place in the market under the name of "imitation creamery." Cleansed or renovated butter would be a reasonably honest name for this article; it should be marked by some such distinctive title, and so as to identify it, all the way to the consumer, like oleomargarine.

This class of butter is in all our markets in immense quantity. I lately gathered information indicating that ten million pounds of it were made last year in three western States but sparsely settled, and this was only one of several producing areas. I have described the poorer and most

objectionable grades. A somewhat better class of goods is obtained by gathering butter in mass, as churned and preferably unsalted, from the farms where made or the nearest country stores, and then working it over at the factory without melting, but all comes to market without distinction as to origin. It stands in the quotations of the day the equal of Eastern dairies and of western creameries, excepting what are known as "extras" in both those classes, and is a much more serious competitor of fresh, sound, farm dairy butter and the lower grades of creamery butter than any form of acknowledged butter substitutes. This is an incomplete but fair presentation of the evil. I submit that it demands attention; something should be done about it.

Under the new law of Congress (approved June 6, 1896), that counterfeit article now legally known as "filled cheese," although more correctly "lard cheese," is subjected to the same general provisions for preserving its identity and making it unmistakably known to buyers in any quantity as in the case of oleomargarine. This cheese law is even more drastic in its operation, because the license fee to retail dealers is so large in proportion to their average gross sales that very few of these licenses are being taken out, and hence there are no legal agencies for retailing this commodity, or next to none. Retail trade in filled cheese is hardly profitable enough to tempt dealers to sell in violation of the revenue laws, and risk the severe penalties attached. Filled cheese seems likely, therefore, to disappear from retail markets all over the country.

But, with the exception of a few State laws, there is nothing to prevent the manufacture and sale in any quantity of "skim cheese," or cheese made of skimmed milk. The State laws which attempt any control of this matter simply provide, as a rule, that skim cheese shall not be branded and sold as "full cream;" some require that it shall be marked with its true name, Wisconsin *shape*. But most of these laws, in their execution if not in their intent, refer to cheese made of fully skimmed milk, or that which contains very little fat. This class of cheese little needs legal restriction or an identifying label; it is easy to recognize, and, while varying somewhat according to skill in making, will ordina-

rily be assigned to the "white-oak" variety in grade, without hesitation. But cheese is made from whole milk which ranges in its contents of fat all the way from two and one-half to five per cent. There is as much difference in fat, and hence in quality, between these limits, as between cheese made from two and one-half per cent milk and that fully skimmed. Under all the State laws, a cheese from three per cent milk is as much entitled to be branded "full cream," and bear the State trade-mark, as one from five per cent milk. Besides this inequality, there is unquestionably much cheese on sale, marked "full cream," made from milk which has been partly skimmed. The unfairness which results, often in the form of intentional deception, is in effect as much a fraud as was filled cheese, although differing in kind. There is no moral distinction between selling as genuine cheese an article which has a part of its natural fat removed, and one which contains a full allowance of fat but of a wrong kind. The skim and part skim cheese evil remains to be dealt with in some effective way. Until properly regulated, it will continue an annoyance and injury to the manufacture, sale and use of first-class cheese. It is as easy to make a fat test of milk which is to be made into cheese as of that which is to be made into butter. The quality (or fatness, so to speak) of a lot of milk being known, the fat percentage of cheese made from it by a competent maker will be known also. And a skilful operator can measure the fat in a sample of cheese, with a Babcock tester, as accurately and almost as easily as milk can be tested. All admit that, if well made and cured, the proportion of milk fat in cheese measures its quality and value. Such being the facts, I propose that all cheese, in the usual commercial or factory form, be graded and branded according to the fat content of the milk from which it was made, using the nearest numeral as the distinguishing mark. An allowance of possible error to the extent of one-half of one per cent might be made; this is unnecessarily liberal, but would accommodate the grading. By this plan, cheese would be marked 0, 1, 2, 3 and 4. The higher the number, the better the grade of cheese. A full-cream cheese of high grade would be marked 3. Numbers 1 and 2 would be for

different grades of part skims, and 0 for full-skim cheese. The numerals 5 and 6 might be added for cheese made from enriched milk. This plan is suggested as being simple and accurate, easily understood when adopted, and enabling the proposed grading to be easily tested and verified.

Full as much difference exists in the quality of milk contributed to the general urban supply as in the case of cheese. It is absurd to place all milk on an equality in the market which reaches the legal standard, whatever that may be, and regardless of the degree to which some of it may exceed the standard in quality; and it is unjust, as well as equally absurd, to give the same legal status of skim-milk to all falling below the standard, no matter how slightly deficient in fat. With a standard of three and one-half per cent of fat, and prevailing prices being four cents per quart for skim-milk and eight cents for whole milk, an article containing 3.4 per cent of fat must be sold as skim-milk, while one with 3.6 per cent, or even less, may sell for twice as much, because it meets legal requirements, and most city buyers would accept it as satisfactory. Milk should be graded like other commodities, and sold on its merits according to its proper grade. Butter fat is the determining factor in the commercial value of milk, and this fat is easily and quickly measured by the tester. Therefore I would give fresh milk five grades, 1, 2, 3, 4 and 5, these numerals to indicate the percentage of fat guaranteed as the minimum contents, except that No. 1 should be allowed a margin of one per cent and cover all skim-milk. No. 2 would pass as partly skimmed, or low grade, 3 as whole milk, and 4 and 5 as milk of extra quality. At the rates now ruling, No. 5 would probably retail at ten cents, No. 4 at eight cents, No. 3 at six cents and No. 2 at four cents per quart. With proper regulations for plain marking of cans, bottles, jars or other vessels, and for enforcing the guarantees of dealers and salesmen, the dubious legal standard for milk might be abolished, buyers protected as well, and better justice done than under the present system. The suggested regulations would be as easy to enforce as existing laws and ordinances. The plan is not wholly new, some features of it having been in practical and successful use in at least two places in this country.

For some years a prominent Philadelphia dealer has sold different grades of milk, guaranteed as having at least three, four and five per cent of fat, and I recently found a German-American dairyman selling to families and invalids in Los Angeles, Cal., milk in bottles, respectively marked and guaranteed to carry four, five and six per cent of fat. These high grades were obtained by adding cream.

There are other needed reforms in the milk trade. As now conducted, there is inexcusable loss of labor and other wastes. The business will never be right so long as consumers pay twice as much per quart, and frequently three times as much, as the producer receives. Middlemen seem to be a necessity in this, as in other lines of traffic, but they are an incubus if not an evil, which should be eliminated as far as possible. There is certainly no sense in delivery vehicles travelling ten times as far in the aggregate as is necessary to serve properly a given number of families or customers. And the night work in transfers and deliveries, which is so fatiguing and expensive, is all unnecessary. Co-operation in supply and delivery is possible, if men will only co-operate; but the army of small dealers and drivers, now living on what the producer loses and ought to save, will not cut off their own heads; the reform movement, where it is practicable, must begin with producers. Witness the success of the milk associations at Syracuse, N. Y., and at Springfield, Mass. Why are there not more of these excellent co-operative enterprises? The night work and early-delivery custom is founded on a mixture of ignorance and prejudice, — if these are not the same thing. This prejudice on the part of consumers can be broken down, by proper effort. There is no good reason why milk should not be delivered to customers in cities and towns, like most articles of merchandise, at such time during the day as best suits the convenience of the seller. One firm in New York City has solved the whole problem by supplying at a fair price an article of milk so good that consumers are glad to get it at any time, and this is delivered all along through the regular business hours of the day, in a manner economical and satisfactory to the dealers.

Fourth. — In dealing with the desirability of extending

our markets for dairy products, at home and abroad, some of the ground already traversed must be gone over again. but briefly.

The business side of our dairy interests requires the attention of merchants as well as of farmers and creamery-men. The demoralization of the cheese trade has been explained. To re-establish confidence and encourage general consumption, which has been decreased in marked degree, will require systematic effort. The place of cheese as an economical article of food, rather than as a condiment, must be brought before the people. It is a cheap and satisfactory substitute, in part, for expensive meats. Differences in variety of cheese, in flavor and in style of package, must be used to best advantage to stimulate sales. Retail merchants must be content with the reasonable profits usual on other semi-perishable food products, instead of the sixty, eighty and even one hundred per cent advance on cost price, which is so commonly placed on cheese. If local dealers maintain the exorbitant prices which repel consumers, factories should work up a trade by sending delivery wagons through their neighborhoods with cheese in small, attractive shapes for family use. This has been successfully done in numerous places, the factory netting a cent or two more than wholesale rates, and consumers being supplied at prices much below their local markets.

It is unfortunate that cheese factories have been so generally closed, and the manufacture discontinued over large areas. In every New England State the production of cheese has steadily decreased for thirty or forty years. While the price of butter was proportionately high, the tendency to make more butter and less cheese was natural. But, now that the present and prospective price of butter is low and that of cheese high in proportion, there should be a revival of this branch of dairying, providing the demand for cheese continues to improve. It would be expedient to have one creamery fitted to make cheese in every active creamery district, and prepared to shift its product from butter to cheese at any time that an excessive receipt of milk or an extremely low price for butter makes it desirable.

The occurrence of a surplus in dairy products of any

kind always means a surplus of milk. The question is as to the best form into which to convert the milk, for relief of the market or for preservation so as to gain time. Cheese is the best cow product to bear transportation and reach distant markets, and it is the best for preservation, as the condensed-milk business seems to be overdone, or at any rate very uncertain. Every pound of cheese made means just so much milk or butter out of the way, and every pound additional of cheese consumed is a direct gain and relief. Although the least among the different branches of dairying in this country in geographical distribution and in volume and value, cheese-making is still of much importance to this entire industry. It serves as a sort of safety valve to dairying as a whole, and every one having this branch of husbandry at heart should do what he can to encourage the making of cheese, and help to stimulate the cheese trade, both foreign and domestic.

The condition of our export trade in cheese has been already described and compared with former years, especially as to the British markets. Courageous effort should be made to regain what has been lost; but, if one outlet fails, the thing to do is to seek for others. New foreign markets for butter should also be sought, east, west and south, no matter how distant. It is by no means hopeless to try to establish a market for our better grades of butter in Great Britain, but we must go at it in a more sensible way. The sending over of little else than poor grades is very impolitic, although it may afford temporary relief. Only the other day a large lot of "imitation creamery," or the better class of ladled goods, was sent to London, which had been in cold storage at Chicago for two years, awaiting market. It is easy to understand the reputation which American butter will acquire from such consignments as this. Such policy is suicidal, and the sooner attempts are made to counteract these effects, the better for our future needs. To find these foreign markets desired and assist our merchants to occupy them, the United States consular service should be actively employed, or it may be well to place special agents on this duty, at promising points.

Any one who carefully examines the subject will find

that the dairy interests of the United States have passed through the recent period of decline in farming and farm products, in better condition, relatively, than any other important agricultural specialty. If time permitted, an array of facts and figures could be presented in support of this statement which would convince any doubters. There must be numbers here present who can substantiate this assertion by their personal experience. A can of milk, a tub of butter and a box of cheese, jointly and severally, have a purchasing power to-day approaching much closer that which they had ten, fifteen and twenty years ago, than is the fact as to a bushel of wheat or corn, a barrel of apples or potatoes, a carcass of beef or pork, a bale of cotton or a cask of tobacco. The same is true of horses, hay, wool, pelts, hides, tallow, poultry, eggs, wax, honey, vegetables and fruits.

This relative position gives to dairying a leading place, which should be held. If it can be held, and if the reforms and improvements suggested can be measurably attained, dairy farming in the United States will maintain its place as the most profitable, the most progressive and the most intellectually stimulating branch of agriculture in America.

Mr. Geo. M. Whitaker (of Boston). I want to supplement the major's excellent address with a word. Comparing the exhibit of seventeen years ago with that of to-day, the one down stairs includes fifteen exhibits of creamery butter, and, on the assumption that a creamery represents only twenty private dairies, the exhibit represents three hundred dairies, and without doubt each creamery represents several times twenty private dairies. It seems to me that it is well to bear that in mind, in connection with the speaker's comparison of statistics. That figure fifteen is comparatively small. It does not sound large, but, if you bear in mind these fifteen exhibits represent an immense number of dairies, the importance of our exhibit to-day will be realized.

While I am on my feet I want to say another thing. Major Alvord has alluded to the food value of skim-milk. I wish the people of Massachusetts, particularly in Boston

and vicinity, could have the facts so impressed upon them that they would become large consumers of skim-milk. It would relieve the situation very much. There is altogether too much adulteration of whole milk with skim-milk. As the situation is to-day, there is a great deal of skim-milk coming in and replacing so much whole milk, and making the surplus larger. When milk has been adulterated with water, chemists can with difficulty determine the fact that the whole milk has been watered. If to three or four cans of whole milk a can of skim-milk is added, the relation of the different constituents is such that a chemist would hardly want to go into court and say that milk was adulterated. The result is that we have reason to believe that to-day large quantities of skim-milk are used in Boston to adulterate whole milk and to add to the general demoralization of the market there.

The Chairman. There is now an opportunity for questions.

Mr. E. W. Wood (of West Newton). As several of the members of the Board are obliged to leave at the close of this session, I desire to say at this time that when the Board at its annual meeting decided to come to Franklin County to hold its winter meeting, at the home of the dean of the Board, they anticipated that they would have an unusually agreeable and profitable meeting. I need not say that they have had such a one. The interest and attendance during the sessions has fully proved it, and I desire to offer in behalf of the members of the Board, a vote of thanks to the Greenfield Club for the entertainment last evening, and also to the citizens of Greenfield for the ample and pleasant accommodations they have furnished for holding our daily sessions.

Secretary Sessions. I desire to second that resolution. I want to say that it was with a great deal of pleasure that I received for the Board of Agriculture the invitation from the Franklin County Agricultural Society. I feel that Franklin County is the ideal place in all Massachusetts to hold an agricultural meeting. It is the county leading in agricultural interests, having the best stock and producing the largest amount of dairy products. It has perhaps the

largest number of well-to-do, intelligent, independent farmers, men who can meet on an equality the men of every other calling or profession in the State, men who have been sent by the Franklin County farmers to represent them in the General Court, who could compare favorably with the lawyers, with the physicians, with the merchants, with the business men of our State, who represent other parts of the State in the Legislature.

I am happy, Mr. Chairman, to express my gratification at the reception we have met here, the steady efforts to assist me in looking after the details of the meeting, before the meeting was held, at the meeting and at all times. I want to return, with the thanks of the Board, my own individual thanks to our dean, who has interested himself in all these matters and given his best effort to relieve me of anxiety and to make sure that the arrangements were made perfect. I want also to include the delegate from Franklin County, Deacon Taylor. It has been one of the most successful meetings that has ever been held, and it is very largely due to its being held in the ideal place in Massachusetts to hold such a meeting.

Mr. G. E. Taylor (of Greenfield). When the invitation was given and accepted for the Board to meet here, I felt that perhaps we had a burden on our hands; but I felt, too, that I understood Greenfield and Franklin County, and I want to say here and now that I have met with a most cordial response in whatever I have asked gentlemen to do. I want particularly to thank Mr. Wood, who furnished the banquet last night, and the Greenfield Club. The Franklin County Agricultural Society has joined in heartily, everything has gone pleasantly, and I feel very grateful for all that has been done.

Secretary Sessions. I hope the gentlemen will not consider that this is the benediction. We have an inviting programme for the afternoon. The only reason that this was brought in here was because some of the members will be obliged to leave on the afternoon train.

The Chairman. You hear the motion, as seconded by our secretary. All those in favor will manifest it by rising. The motion is carried by a unanimous vote.

Mr. J. G. Avery (of Spencer). I was much interested in the remarks of the speaker in regard to the export of butter. It was my privilege to live in London a few years ago. A man there had a large consignment of American butter, and after repeated effort to dispose of it, the agent who had it in charge finally sold it to a railroad company to lubricate their car axles. That shows the importance of sending only such goods to a market as the market demands. In England and France, where I passed several years of my life, the fresh, unsalted butter is the most popular. When we became accustomed to it we preferred it, and soon became extravagantly fond of it. In France it was served in little patties floating in cold water. With hot cakes it made an extravagant breakfast, for the butter cost more than the cakes. In England and France the unsalted butter is brought to market fresh every morning.

Adjourned at 11.50 a.m.

Afternoon Session.

The Chairman. The hour to which we adjourned has arrived. The first paper this afternoon is on "The use of pure cultures in butter-making." It gives me great pleasure, ladies and gentlemen, to introduce to you Professor Cooley of the Agricultural College.

Professor Cooley. Mr. Chairman, ladies and gentlemen: No one regrets more than myself the circumstances that compel the Agricultural College at this time to be represented here by one of the least of her sons; but I have this thing to say, that, if I am not a leader in science, I am a farmer, and ever since this Connecticut valley was settled my ancestors have been here as farmers; and, more than that, I am proud to say that I am a Franklin County boy.

The subject which has been assigned to me is one which I suppose does not appeal very forcibly to the farmers. If this is unfortunate, it is not my fault; it is my misfortune. I want to say that there are a great many things in the world that we do not half appreciate on first acquaintance. There are those which we are inclined to make light of at

first, but after better acquaintance we recognize them as our friends. Just so in the world of microscopic life. As we know better those little organisms which form such an interesting study to many people to-day, we are beginning to recognize among them some of our best friends. They are not all by any means our enemies. My subject is "The use of pure cultures in butter-making."

Use of Pure Cultures in Butter-making.

BY PROF. F. S. COOLEY, AMHERST.

Our time is fast making its history as a period of wonderful discoveries.

The inventions of the last decade in electrical appliances and photography are without precedent in the annals of the race. Not less startling nor of less vital interest to us are the recent discoveries in the world of microscopic life. Facts lately disclosed in the study of bacteria are of marvellous significance.

These little plants, so minute that it is necessary for thousands of them to unite to form a speck large enough to be seen by the naked eye, have lately been found to be involved in a vast number of functions and changes of every-day occurrence. Diseases and maladies of the animal body are found to be largely due to development and multiplication of minute living organisms. Consumption, diphtheria, cholera, malaria, typhus and scores of other diseases have been found to be communicated and caused by bacterial growth. Similar organisms on the roots of certain farm crops have been found to enable them to draw on the air for supplies of valuable plant food.

Of vital interest in the living world, they seem to be of at least equal importance in the world of dead organic matter. As discovery extends itself, it looks as if we should be able ultimately to trace every change in dead organic substances to bacterial development. The putrefaction of meat, the decay of vegetable matter, the fermentations of manure, — all operate from the same causes. Fermentations of beer and spirits, the souring of feed stuffs on becoming moist, the sweating of hay, result from the presence of micro-organisms. The curing or sweating

of leaf tobacco, producing the flavors and qualities esteemed by users of the weed, are but natural results of bacterial development. Indeed, the differences between Havana and Sumatra, and Connecticut valley and Wisconsin tobacco, have been explained as largely due to different species of ferments concerned in their sweating. It is claimed that tobacco from this valley can be sent to Cuba to sweat, and come back with all the aroma of genuine Havana.

The happy hunting ground of a great variety of bacteria is milk. Perhaps no other substance affords so congenial food and surroundings to large numbers of them. So agreeable is it, that it is difficult if not impossible to keep them out of normal cow's milk. The milkman's problem is seriously complicated by their presence. They sour milk, they putrefy it, they make it ropy or bitter, and often change its color. Unless it can be made to satisfy the consumer before these changes set in, it becomes an almost total loss. It is the aim of every good milkman to check and reduce their action as far as possible. To this end he uses precautions to prevent their entrance, makes the conditions as unfavorable as possible for their development and in some instances takes measures to destroy them after they become established.

To keep germs out of milk, one must know how they enter it. The udder of a healthy cow contains no germs, and milk as it comes from the teat is uncontaminated. If germs could subsequently be excluded, milk would keep for years without change; but just as soon as it leaves the udder the assault is made. The sides of the cow and her belly and udder are teeming with life. Even the orifices of her teats are invaded. By rejecting the first streams of milk and thoroughly cleaning and moistening the sides and udder, the numbers are greatly reduced. Milkers' hands and clothing are sources of contamination, and should be clean before milking. The air of the stable is reeking with germs, and should be ventilated thoroughly. Milk must be taken out of the stable at once. Cows milked in open air give a product freer from germs than those milked in a stable.

Warm milk allows the bacteria to multiply very fast,

therefore milk should be cooled at once to a low temperature, for germs are partially paralyzed by the process, and milk keeps much longer cold.

Sterilization by heat is sometimes practised to destroy bacteria in milk and prevent change by souring and putrefaction.

Pasteurization, or partial sterilization, is also resorted to, and secures freedom from change for a time, without rendering the milk so objectionable and unwholesome to weak stomachs as sterilizing does.

Unwelcome as these ferments and the changes they produce are in milk, they are essential to the profitable manufacture of butter and cheese. The ripening or curing of cheese and flavor developed depends almost entirely on bacterial growth. The different kinds of cheeses, Cheddar, Stilton, Gloucester, etc., owe their difference in a measure to different organisms involved in ripening. In butter-making they are not less important.

The production of a desirable and uniform flavor in butter has been the subject of a great deal of study and careful investigation in the last decade. The earlier work on this subject was performed by the Danish scientist, Storch. In 1890 he found that the production of a first-class flavor in butter was dependent on the kind of bacterial life that was present in the cream. If sweet cream was pasteurized and made into butter, it lacked the delicate aroma that was so much desired. In studying the different species of bacteria that were isolated from ripening cream, he finally succeeded in separating a form that had the property of producing a highly agreeable flavor when introduced into pasteurized cream. Storch's experiments opened up a practically new field for investigation, which has since been assiduously cultivated by several Danish investigators, by Weigmann in Germany and Conn in this country.

Previous to the discovery of the function of bacteria in ripening cream, and the separation and cultivation of those forms calculated to produce highly agreeable flavors, the manufacture of beer had enlisted the talents of some of the most distinguished scientists. It is a curious fact that beer has been more carefully studied, with a view to increasing

its value, than has milk, and that the discovery of the source of desirable flavors in butter was the outgrowth of investigations on the production of delicate and much-sought flavors in beer. Indeed, the use of pure cultures of bacteria in the fermentation of beer, to induce desirable flavors, has been common in Germany for many years.

As has been stated, sweet cream butter lacks the fine flavor and delicate aroma of butter from cream nicely ripened, and it finds but little sale in American markets, although in some places, Paris especially, there is a growing demand for butter made from fresh cream. This butter will not keep as well as that from well-ripened cream. American markets call for butter that possesses the "quick flavor" and subtle aroma that can only be produced by systematic ripening.

Our best butter-makers owe their success largely to their skill in tempering and producing just the right degree of acidity in cream; and the value of butter in the market, due in a large degree to its flavor, is dependent mainly on the management of the cream before churning.

The ripening of cream is the direct result of the growth of bacteria, which, in process of development, change some of the constituents (probably the milk sugar) into acids (lactic acid). This ripened product is sour cream, but must not be allowed to sour too much.

Under the most careful management it is difficult to get the same flavor in butter day after day; but the product varies, and it is often puzzling to the butter-maker to account for the lack ot uniformity in the article he makes. The explanation must be sought in the development of bacteria. The cream as gathered contains a large number of species. Sometimes one predominates, sometimes another. The flavor is produced according to the variety of bacteria which gains ascendancy in souring the cream.

In order to secure a uniform product, many butter-makers ripen their cream by seeding with a *starter* from a previously made article which possesses an agreeable flavor. This is done by putting into freshly set cream buttermilk from a previous churning, or a small amount of cream from the vats already ripened. In this way the same varieties of

bacteria are propagated day after day, and a uniform flavor is to be expected. There are, however, in this method of work such a large number of species of bacteria that oftentimes the worse species gain such a prominence that an objectionable flavor results. Whenever an undesirable flavor develops, butter-makers seek to overcome the difficulty by seeding their cream with fresh stock, procured from a neighboring creamery or dairy which is known to develop good flavor.

I have in mind a case reported a short time since of a creamery where the fresh-gathered cream was pumped up into the tempering vats. The butter produced was of an exceedingly agreeable flavor, until the pump was overhauled and cleaned. It was found to be covered with a sour slime inside, full of bacteria. The removal of this filth and slime, with its content of organic life, was virtually "killing the goose that laid the golden egg," for the butter made afterwards showed a loss of the flavor for which it had been esteemed.

A step taken by many German butter-makers, at the suggestion of scientific investigators, was to discard natural ripening for ripening by cultures carefully selected for the fine flavor they imparted to butter. There are several preparations in use in Germany for desirable fermentation of cream, as well as for agreeable fermentation of beer.

In America there are two pure cultures on the market for producing uniformly fine-flavored butter, known as "Lactic Ferment," prepared by Chr. Hansen; and "Bacillus 41," by Professor Conn. The latter was isolated from a sample of sterilized milk, brought from Uruguay, which had been improperly preserved. The claims made for these artificial ferments are three: —

1. *Uniformity of Product.* — As the same culture is renewed from day to day, or every week, the same varieties of bacteria always develop, and the flavor of the butter remains very uniform.

2. *Increase in Flavor.* — Not only is the product more uniform, but the "quick, high flavor" so much prized is secured with certainty by use of the proper ferment.

3. *Improving the Keeping Quality.* — Weigmann and Storch found that butter of extremely fine flavor rarely kept

as well as an article less well flavored. The two things seemed to be antagonistic. This has been overcome in a measure by using two organisms in the starter, — one for flavor, the other for keeping quality.

Are these three claims sustained? Extensive experiments have been made at the Wisconsin Dairy School and Experiment Station to test this point. There is not time to discuss the experiments, or even describe the methods adopted, but we must hasten at once to the results.

A part of the tests were with "separator" cream, seeded after separation; the rest were with gathered cream. Some of the latter were seeded in the cans before the gatherers started, the others were seeded when the cream arrived at the factory. In each the cream seeded with pure cultures was compared with an equal amount of the same cream allowed to ripen in the natural way. Both settings were developed quickly, at high temperatures, and slowly for two days, care being taken to preserve identical conditions between compared settings. The cream was churned at the same temperatures, colored, washed, salted, worked and packed in exactly the same way. It was then sent off, under cypher numbers, to be scored. Every sample was scored when fresh by two or more experts, and again after remaining in cold storage from three to five months. No factor was taken into consideration in scoring except flavor when fresh and flavor when kept for three to five months in cold storage. This one factor counted fifty points for perfection. The results of the score are as follows: —

	Gurler.	Barber.	Wolverton.	General Average.
Number packages scored,	14	22	10	–
Average score of normal butter,	47.0	47.3	44.2	46.9
Average score of B. 41 butter,	45.6	46.4	44.6	45.8
Diff. in favor of normal butter,	1.4	.9	—.4	1.1

The scores of Gurler and Barber were of the fresh butter, those of Wolverton being of the stored article. The fore-

going table refers to separator cream, ripened forty-eight hours. Hansen's lactic ferment did not enter into the comparisons generally and the experimenters did not feel warranted in drawing conclusions from their meagre results with that culture. I should like to state that in the four or five tests made the average score was 45.4 for the fresh butter from lactic ferment, slightly below either of the others. Lactic ferment butter received a higher score by a full point when used in unpasteurized cream than in cream that had been pasteurized.

The experimenters drew the following conclusions from their tests : —

1. Cultures of Conn's B. 41 did not improve the flavor of butter either from separator cream or gathered cream. On the contrary, there was a perceptible difference in favor of natural ripening.

2. With separator cream butter in cold storage, that made with B. 41 deteriorated less than did normal butter; and although the latter scored considerably higher when fresh, it scored slightly lower when taken from storage.

3. From gathered cream the pure culture had no advantage over natural ripening in the keeping quality of its butter.

4. There was little difference in the uniformity of B. 41 and natural ripening, what there was being in favor of the latter.

5. In special experiment to test the assertion that B. 41 retards souring, the contrary was observed; *i. e.*, it was more acid than normal cream under identical conditions.

6. These conclusions do not agree with the results that have been generally reported where B. 41 has been used for cream ripening. This may be attributed in part to close attention to the details of manufacture rather than to the use of a starter.

The B. 41 was used in unpasteurized cream, as is recommended — not in pasteurized, as is the common practice with other cultures.

In the brief time at our disposal last winter, in the Massachusetts Dairy School at Amherst, I carried out (with

Mr. Michels, our butter-maker) a single careful test to determine the flavors of butter from B. 41, lactic ferment, natural ripening and a bacillus separated by one of our own men. In our own test almost identical conditions prevailed: 47 pounds of cream in each lot, ripened at 62° F.; .38 per cent acidity in each case; churned at 56° F.; washed once; salted $\frac{3}{4}$ ounce to pound; fourteen minutes for churning; and 14 pounds butter, net. The butter was scored by A. Belknap of Boston and H. B. Gurler of De Kolb, Ill., with the following results: Belknap ranked B. 41 best, the others about the same; Gurler ranked B. 41 poorest, the others the same; Mr. Michels, Professor Brooks and myself agreed with Belknap in preferring B. 41, though the difference was slight.

Many practical butter-makers are taking up the use of one or the other of these cultures for ripening cream, and they come to rely on them with a good deal of confidence when the merits of the cultures have been thoroughly tried. A practical creameryman from Wisconsin, who is unusually successful in obtaining a high price for his products, told me he would just as soon try to get along without color as without B. 41. His brother manages a cheese factory twelve miles away, and has sometimes driven the distance to secure a starter from the pure culture of the creamery, when for some reason his own had failed.

The testimony of the most progressive manufacturers of dairy products leads us to the opinion that pure cultures will become a valuable adjunct to the manufacture of choice articles. I believe that the cultures have come to stay, and hope that we shall hear of further tests relative to their value in the near future.

QUESTION. Why do we get a better flavor of butter in June than in December?

Professor COOLEY. I suppose it is because December bacteria are different from June bacteria.

Mr. GRINNELL. Does storing cause any change in the butter?

Professor COOLEY. Certainly there is a change in butter

from fresh to that which has been in storage a long time. It lost in this case a little less than three points in four months, on an average. The pasteurized kept its flavor slightly better. The lactic ferment gave an average score of 45.4. That is a little lower than the others. In experiments in Wisconsin, in unpasteurized cream the flavor was two points better than in the pasteurized cream, with the same culture.

Down stairs there are five packages of butter that I made on Monday before coming to this meeting, from five lots of cream as nearly identical as we could get them. The cream was cooled before separating for ripening. One was pasteurized B. 41, one the lactic ferment, one Boston butter culture, one ripened naturally and one was made from fresh cream separated that morning and put right through the churn. Here are the scores that your expert judges have placed on these butters. I hope, if any one is interested, that they will take the pains to taste them, and see if they can taste any difference in flavor.

No. 1, Boston butter culture; scores 36 by Mr. Harris and 38 by Mr. Douglass. There is a difference in the judges.

No. 2, ripened naturally; scores 36 and 37.

No. 3, that is the sweet cream; scores 38½. We would hardly expect that.

No. 4, the pasteurized B. 41; scores 37.

No. 5, the lactic ferment; scores 36 by Mr. Harris and 39 by Mr. Douglass.

I want to say that Mr. Harris found much fault with the way that butter was put up. I had just learned that the Wisconsin people had used a new kind of wrappers, and I put them on my butter, and as a result the butter has more of the flavor of the wrapper than of the culture. That is what Mr. Harris says. I doubt if you could tell it; I cannot. It is a fact that the sweet-cream butter has now a better flavor than the other samples, because it had no acid to act on the oils of the wrapper and extract the flavors to itself.

Question. What are the wrappers made of?

Professor Cooley. The wrappers are of wood, — ash, I think.

QUESTION. At what temperature must cream be to be pasteurized?

Professor COOLEY. I would rather be excused from answering that question, there are so many different opinions. The temperature must be high enough to kill most of the bacteria, but it must be so low that a permanently cooked flavor will not be left in the cream when cooled, and that is about 158° F.,—that is not far from it.

Mr. GRINNELL. Your experiments are what you have been reporting on. How much does butter deteriorate in cold storage,—how many points? Did that come within your experiments?

Professor COOLEY. That did not come within the limits of our experiments. The figures that I gave from the Wisconsin experiment station would have a bearing on that, showing a deterioration of about three points in four months' keeping.

The CHAIRMAN. We hope later on in the afternoon to have an opportunity for questions and discussion of our papers, but there are so many of them that we shall be obliged to have all the papers first and the discussion afterward. Our next paper will be on "Food value of dairy products," by Mr. GEO. M. WHITAKER of the Massachusetts Dairy Bureau.

Food Value of Dairy Products.

BY MR. GEO. M. WHITAKER, BOSTON.

I am assigned the task of preparing a ten-minute paper on a five-hour subject. Hence to limitations of ability are added those of time; and I must content myself with the barest statement of results, eliminating reasons, authorities and explanations.

Average milk has 13 per cent of solid matter in solution in 87 per cent of water; or, in other words, average milk has 13 pounds of solids in 100. At 6, 7 or 8 cents per quart, milk costs the consumer $2.79, $3.25 or $3.72 per 100 pounds. The milk solids, which are the portion of milk of value, cost, therefore: 21.4 cents per pound, when milk is six cents per quart; 25 cents per pound, when milk is seven cents per quart; 28.6 cents per pound, when milk is eight cents per quart. This is from 21.4 to 28.6 cents per pound for solid food which has no waste and is all digestible.

Let us see how this compares with some other articles.

If you buy a pound of sirloin or rump steak, about two-thirds are refuse or water; and if you pay 25 cents per pound, the clear nutriment costs you 75 cents per pound.

Your Thanksgiving turkey was 32 per cent bones and other refuse, and 45 per cent water, leaving only 23 per cent of nutrients. This makes the nutritive portion of your turkey cost 87 cents per pound, — if you paid 20 cents.

Of the lobster, 62 per cent is refuse and 31 per cent is water, leaving only 7 per cent of food, which costs you — if you pay 12 cents per pound — $1.68.

Ham contains 52 per cent of nutrients, much of the moisture having evaporated during the smoking, and at 15 cents per pound the food costs about 30 cents.

The shad has 85 per cent of refuse and moisture, and at 25 cents per pound the nutrients cost $1.75 per pound.

I am aware that I have selected some of the more costly foods, but they are such foods as people even in moderate circumstances purchase as necessities. If I had selected others, the fact would have been unchanged that when we compare pound with pound of clear, solid food, free from any waste or refuse, milk is one of the cheapest foods there is. Many consumers regard it as a luxury, to be bought by the pint and used sparingly. Were its cheapness as a food fully understood, its use would be greatly increased and the surplus would be greatly reduced.

But what kind of food do we get for this money? The answer necessitates a brief explanation of the uses of food.

The human machine, like the steam engine, must have food to develop warmth and force. The human machine, like inanimate machinery, is continually wearing, and the worn-out parts must be replaced; but the human machine is built up and the wear made good by growth from within. Special food is required for each function, hence we need fuel foods and wear-and-tear foods. The fuel quality of the fuel foods can be measured, and the amount needed by the human system under different conditions has been estimated. The carbon principle predominates in these foods, and they are frequently called carbohydrates and fats. The caloric is the unit of measurement, and a man doing a moderate amount of work needs 3,500 calories per day.

The wear-and-tear or building-up foods have nitrogen as the leading essential constitutent, and in the form needed for food are called protein. A man doing moderate muscular work needs .28 pounds of protein per day.

Now, 1 quart of milk contains .08 of a pound of protein and 650 calories, or approximately one-fourth of the amount of both fuel and wear-and-tear foods needed to support a man one day doing moderate muscular work. Hence we find as other points concerning the food value of milk that it is not only cheap, but that it has the proper kinds of food and in correct proportions.

	Protein, Pounds.	Calories.
Needed by man doing moderate work,	.28	3,500
In four quarts of milk, ...	.32	2,600

If a person consumed only four quarts of milk in one day, he would have taken enough food to work on, but slightly more protein than was necessary, and be a little deficient in the fuel foods. Substituting 16 ounces of wheat bread for one quart of milk would be an improvement.

	Protein, Pounds.	Calories.
Needed, ...	.28	3,500
Three quarts of milk, ...	.24	1,950
Sixteen ounces wheat bread, . .	.09	1,280
Total, ...	.33	3,230
Two pounds of sirloin, ...	.30	1,940

The wheat bread and milk ration would not be far out of the way,—nearer to the demands of the system than 2 pounds of sirloin steak.

Change now from wheat bread to 16 ounces of corn meal and we have yet nearer a sufficient, well-balanced ration.

	Protein, Pounds.	Calories.
Needed, ...	.28	3,500
Three quarts of milk, ...	.24	1,950
Sixteen ounces of corn meal, . .	.10	1,650
Total, ...	.34	3,600

Two pounds of corn meal has .20 of a pound of protein and 3,300 calories, and if in making that into bread water is used, nothing is added to its nutritive value. Suppose, however, we mix with it a quart of milk, and we have —

	Protein, Pounds.	Calories.
Two pounds corn meal, ...	.20	3,300
One quart milk, ...	.08	650
Total, ...	.28	3,950

This is just the right amount of protein and an excess of fuel foods. If we used skim-milk the result would be better.

	Protein, Pounds.	Calories.
Two pounds corn meal, ...	.20	3,300
One quart skim-milk, ...	.08	360
	.28	3,660

One pound of wheat flour will absorb a little over one-half pint of liquid, and mixed with milk it has .02 of a pound of protein and 162 calories more food value than it would have mixed with water.

Bear in mind that this is not an exhaustive treatise on foods, and cannot consider such questions as the variety necessary to keep up the appetite and digestion. I can do hardly more than present the bald statement that in a quart of milk is about one-fourth the amount and properties of food for a man doing a moderate amount of muscular work.

A moment in consideration of the products of milk, — butter and cheese. This table tells the story and compares milk and its products with the standard: —

	Protein, Pounds.	Calories.
Man doing ordinary work needs,	.28	3,500
Four quarts of milk contain,	.32	2,600
One pound full cream cheese,	.25	2,005
One pound skim-milk,	.31	1,495
One pound butter,	.01	3,615

The butter, which is the fat of milk, has practically no protein and is very rich in the fuel elements. It is of great food value in balancing rations deficient in fat; and for that condition of invalidism calling for more fat, butter or cream are for many people better than cod-liver oil or patent nostrums.

Cheese, which retains the casein of the milk as well as the fat, has in one pound almost enough protein for a day's rations, but is deficient in the fuel functions. These, however, can be easily supplied in other ways. A pound of cheese has more nutriment than a pound of beefsteak, and cheese should be more used as food.

A half pound of cheese and two pounds of corn meal is —

	Protein, Pounds.	Calories.
Needed,	.28	3,500
One-half pound cheese,	.125	1,000
Two pounds corn meal,	.18	3,300
	.305	4,300

Notice the difference between full cream and skim cheese — the latter is very rich in protein and deficient in calories.

	Protein, Pounds.	Calories.
Full cream cheese, ...	.18	3,300
Skim-milk cheese, ...	.16	750
	.34	4,050

To those who are interested in following this subject I commend the studies of Professor Atwater and his elaborate tables giving the food value of many different materials and also combinations which make perfectly balanced rations. My work in this paper is merely to present a few facts and suggest a few thoughts in connection with the food value of dairy products.

On the food value of milk from the health stand-point I desire to say a word. I am surprised at the extreme positions taken by estimable, intelligent men, who allow their devotion to science, their prejudices or their animosity to divest them of broad-minded, judicial fairness, and to drive them to become narrow extremists. The claim of science as to possible dangers lurking in milk as the may-be conveyer of disease germs is true, and should be admitted. It is also true that milk is a valuable food, and should be more largely used. But why can we not be reasonable, and recognize the real situation? One agricultural writer in a recent article, criticising some of the developments of modern science, sought to score a point by saying that more people had suffered for lack of the food value of milk than from any disease germs contained therein.

With this statement I am not going to quarrel. But, even if it is admitted, should we not do what we can to improve the quality of the milk supply, and help the minority who may receive injury from it? When a man is killed at a railroad crossing, we do not get up a scare against railroads, neither do we look on with indifference because hundreds have previously crossed there with safety. When the deadly properties of sewer gas were discovered, we did not go to the extent of creating a scare against sewers, or go to the other extreme of preaching apathy, because, after all, only

a few of the people whose houses are connected with sewers are injured by sewer-gas poisoning.

We can keep on advocating the increased use of milk, and at the same time can consistently admit possible dangers and work for their reduction. We can even call it a healthy food, and still admit that under some circumstances it may be a source of danger, and work for the reduction of that.

In conclusion: milk is one of the cheapest, well-balanced, healthy articles of food; cheese is a cheap, healthy article of food, standing high in the amount of nutrients it contains; butter is a cheap and palatable source of the needed fats in food.

Persons obliged to practice economy in their food purchases can do so to the best advantage in most cases by increasing the use of dairy products.

The CHAIRMAN. The time has now arrived for what we term our "dairy experience meeting." We have several whom we expect will deliver short addresses and perhaps answer questions. The first is Mr. C. B. LYMAN of Southampton.

Mr. LYMAN. Mr. Chairman, ladies and gentlemen: In the short space of time which is allowed me, it would be difficult to give any elaborate description of the methods which I practice at my own dairy. A few years ago, — fifteen years ago, — the gentleman who delivered the address this morning was down at our place, advocating uniting in creameries. He said the butter would be more popular, and so great would be the amount called for that private dairies would be of no account. He said we would have to go into them, as we could not otherwise sell our butter. I suppose that will be the case in the future, but I am still living and carrying on the same business that I did before. I have only a small herd of cows and a small farm, but what I try to do I try to do well.

Private Dairying.

BY MR. C. B. LYMAN, SOUTHAMPTON.

There is no product of the farm that requires so much care and attention, that is so delicate and difficult to handle in the manufacture, as the product of the cow in the making of choice butter and the marketing of the same. A great change in butter-making has been made within a few years, to the profit of a large part of the farmers, by the establishing of public creameries, thus removing labor from the home to the factory, and making a better article of more uniform quality and commanding better prices than the average dairy product. But there are many farmers so situated that they are not readily accommodated by the public creameries, and therefore are obliged, or think it the better way for them, to manufacture the product of their own cows. To such I would address myself in trying to show what I think of one way of accomplishing the best results.

The first requisite is the cow. Take whatever breed you think best adapted to your conditions, — you must decide after a thorough trial, — and then do your best to improve on that. We have the Jerseys, thinking them best adapted to our farm and giving us a better product than any other breed. They are not yet up to the point of production that we would like, but we are trying hard to reach that result.

Having secured your cows, give them care and treatment to get the best results. Let them have good, roomy stables, well lighted and ventilated. Not many of us can have our stables sheathed and polished, but we can keep them clean and free from unwholesome odors. Give the cows plenty of good bedding to make them comfortable and contented; treat

them gently and keep them free from excitement and fear. Pet them, make them familiar with your presence, feed them regularly and with good rations.

When the cows are in winter quarters our practice is to milk them the first thing in the morning, then give a ration of good hay. After breakfast they are turned out for watering, and the mangers and stables are cleaned of the night's litter. We then give a feed of corn meal, wheat middlings and cotton-seed meal. We give about two quarts of this mixture to each cow, and place it in their mangers. After this we give a feeding of hay and then of corn stover. The cows are then left to themselves until about three o'clock in the afternoon, when they are turned out for water and exercise, and are then given the same course of grain and other feeds as in the morning. You will say that this is not a very extravagant ration, but it has answered our purpose very well. When the cows are at pasture, only a feeding of grain at night is given.

Great care must be taken in milking to have everything neat and the udders clean and free from dust and dirt. Milk quickly and to the last drop. Carry the milk immediately to the dairy room and thoroughly strain. As to the quality of the butter made, I think there is but little difference whether the cream is raised by being put in the old-fashioned shallow pans or in deep open pails, in cold setting by use of the submerged process or by use of the separator. To get the most cream from shallow pans or open pails, the temperature of the room should be about seventy degrees, and the milk should stand from twenty-four to thirty-six hours; for the cold setting the temperature should be about forty degrees, and the milk be drawn off in twelve hours; while with the separator you turn the crank and in a very few minutes you have the cream. We prefer the separator, as we get better results with less care than by any other method or process we have tried.

After the cream is properly ripened it is churned, the buttermilk drawn and the butter washed with salt water and then with clear water. It is then taken out and put into a Reid butter worker, salt is added in proportion of three-quarters ounce of salt to a pound of butter for part, and one-

half an ounce for part, to suit the tastes of the customers. The butter is well worked and put up in one-pound prints, stamped, wrapped in papers and put in a cool place till ready for market. All through this work the utmost neatness must prevail, or you will lose the best results of your labor.

Now comes the most difficult part of the business, — getting customers for your product. Notwithstanding that the fashion is largely for creamery butter, there are still many families who prefer private dairy butter and who are willing to pay a better price, because they can get a better article, which will be firmer and harder, less watery and will go farther and last longer than the butter made at the public creamery.

To secure customers requires patient, hard work, and many a rebuff. If you are near a village, large town or city, market your butter by selling direct to the consumer, and save all of the profit to yourself. When you have secured your customers, serve them faithfully and well; give them a good article every time. Strive to please your customers, and they will stand by you. Serve them regularly, and so that you can be depended upon at a certain day, at nearly the same hour in the day, in summer's heat or winter's cold, in storm or sunshine, then your efforts to please will be rewarded by better prices and a constantly increasing demand for your product.

It is thirty years ago this first week in December that the writer started on a weekly drive of fifteen miles to market his product, taking up the business started by his father about twenty-five years before, and followed by him until he was eighty. He is still supplying many of the same families, and is gaining new ones every year, and rarely has he missed a trip. No week has passed but that the customers have been supplied, and it is very rare that any one of them finds fault with the product or with the price.

But notwithstanding the faithful, hard work put in for so many years, and the obtaining of fairly good prices for our products, we are far from being rich, but have to drive away the blues and keep happy and cheerful under many discouragements, still hoping for better success.

"For summer and winter are one to me,
And the day is bright, be it storm or shine;
For far away, o'er a sunny sea,
Sails a treasure-vessel, and all is mine.
I see the ripples that fall away,
As she cleaves the azure waves before;
And nearer, nearer, day by day,
Draws the happy hour when she comes to shore.

"'But what if she never comes?' you say,
'If you never the honor, the treasure, gain?'
It has made me happier day by day,
It has eased full many an aching pain,
It has kept the spirit from envy free,
Has dulled the ear to the world's rude din.
Oh! best of blessings it's been to me,
To look for the hour when my ship comes in."

Mr. ——. I would like to ask Mr. Lyman what he gets as an average price of butter through the year.

Mr. LYMAN. Thirty-five to thirty-seven cents.

Mr. WARE. I understand that his feed is cotton-seed, wheat middlings and bran.

Mr. LYMAN. No; corn meal, wheat middlings and cotton-seed.

Secretary SESSIONS. Will you please state the mixture to the audience?

Mr. LYMAN. I use a little more of the corn meal and wheat middlings than of the cotton-seed. A little less than a quart a day of cotton-seed, and I feed four quarts of the whole to a cow a day. Equal parts of corn meal and middlings and nearly a quart of cotton-seed meal, the whole averaging four quarts a day.

Mr. WIGHT. How many pounds of butter do you average during the year to the cow?

Mr. LYMAN. I have not looked it up within a year. I think I reach two hundred and fifty pounds to the cow.

QUESTION. You put it up in prints. Wouldn't it be more satisfactory to your customers to have it put up in jars?

Mr. LYMAN. No; I think not.

Mr. ——. The butter put up in prints soon becomes affected by the air.

Mr. Lyman. It does not have any air come to it, if it is properly wrapped in papers. They like it so that they can cut it into squares of a quarter of a pound each.

Mr. ——. My farm home is in New York. I find the butter put up in papers gets tainted very quickly. We always put it up in jars for private families. They covered it with cotton cloth and put salt over it. That kept the air from it.

Mr. Lyman. That is a good way, but mine being fresh every week, it would not make so much difference.

Secretary Sessions. Can you give us about the temperature you keep the cream while ripening?

Mr. Lyman. I like to have it in a room where the temperature is about seventy degrees. I churn three times a week, and my cream is mixed. It stands about thirty-six hours from the time the last is put in.

Mr. Ware. At what temperature do you churn it?

Mr. Lyman. About sixty.

Mr. Bliss. I understood Mr. Lyman to say that dairy butter goes farther than creamery butter. I would like to have him explain how that is.

Mr. Lyman. I have a great many customers who tell me that two pounds of my butter will go as far as three pounds of creamery butter. That is the testimony of my customers. Of course I do not use anything but my own butter, and I could not decide on that point. I do not believe that the difference is quite as great as that, but that is every one's testimony.

Secretary Sessions. There is less water in it.

Mr. Lyman. Yes, sir.

Secretary Sessions. If the audience will permit, we will have all the papers together, and then have the discussion. We want to make sure of the papers, and then use the time in discussion.

The Chairman. The gentleman who comes next is the veteran creamery butter-maker of New England. The first creamery was established in Hatfield, with Mr. Dunham as

the butter-maker. I have the pleasure of introducing to you Mr. D. B. Dunham, superintendent of the Ashfield Creamery Company.

Mr. Dunham. I have a brief paper on my experience in making butter. It may not meet with the requirements here. This is a little out of my line of business.

Secretary Sessions. He is a practical man. He does not profess to be a writer. We want his experience.

Creamery Experience.

BY MR. D. B. DUNHAM, ASHFIELD.

My experience in the manufacture of butter dates back to the year 1874, in Franklin County, N. Y., at which time the so-called creameries were termed butter factories, the milk being delivered at the factory and there set in open shallow pans, holding twelve hundred pounds each. I continued making butter by this system until 1880, when I removed to Hatfield, Mass., to take charge of the first creamery in New England, conducted on the cream-gathering plan, and made the first churning Nov. 25, 1880.

In the first place, to make a first-class article, special attention must be paid to the care of the milk at the dairy, and cleanliness on the part of the producers and collectors is as absolutely necessary as with the butter-maker. I would like to say right here that especial credit is due the patrons of the Ashfield Creamery along this line. I maintain that all cream and butter receptacles and the floors in a creamery should be thoroughly cleansed and kept sweet, and never neglected even for a single day, as is the case in many creameries. In order that the floors may be kept perfectly sweet and clean, the building should be built with good sewerage and drainage, and proper appliances to conduct all buttermilk and drippings off into the sewer. When the floors are allowed to get wet and remain so, the building will in a short time become musty, and consequently affect the cream.

Cream must be brought in sweet, and then, to ripen it, brought slowly up to a certain temperature and held there thirty-six hours, instead of souring it by using the so-called starter, such as sour buttermilk and old cream. Then cream should be stirred frequently and the whipped cream re-

moved, as it sours and turns old very quickly and becomes "cheesy." When it is taken off and churned separately, one can readily see it makes an inferior quality of butter, and will not keep at all; therefore it must necessarily hurt the quality of a whole churning where it remains on the cream and is churned with it.

System must be used in all parts of butter-making. Cream should always be churned at a certain temperature, varying according to the season of the year, and butter should be washed in water of a certain temperature. We often hear of complaints that butter "won't come:" but I am confident in saying that there never was any cream produced that would, if properly cared for and brought to a right degree of heat, refuse to make butter in a reasonable length of time; for in my twenty-two years' experience in butter-making I have never failed to have my churnings come in the proper time. Some might say that in private dairies the result might be different; but I would add that I have churned each producer's cream separately many times, and have always been just as successful.

I salt the butter in its granular state, in a revolving box churn, and then take it out on a Mason power worker, and after it is worked print it on a printing table. After becoming sufficiently hardened in the refrigerator it is brought out and wrapped in printed parchment paper on a table especially for that purpose, and put into trays ready to be placed in the large cases. Some of the butter, of course, is packed in five-pound boxes and small tubs, if so ordered. We use cloths on top of the boxes, and the tubs we line with parchment paper. Our butter is all shipped twice a week, a large amount being sent to private families in New York and other cities.

Of course, it goes without saying that, in order to hold a private trade, one must make a good and uniform article. Uniformity is one of the essential things necessary to retain private family trade. We at our creamery have standing orders with certain city families for a certain amount at regular intervals, put up in fancy prints and salted to order.

As there is so much discussion about and so many questions asked concerning mottled butter and white specks, which

as a rule are so foolishly answered, it may be well to refer to the matter right here. Streaky and mottled butter is always caused by an uneven distribution and working in of the salt. The light or mottled part is the natural color, without the salt. Good, first-class butter-makers do not have this trouble, because they understand how to have their butter come at the the proper temperature, so that the salt will act uniformly on it. White specks in butter are caused by overheated cream, which causes a curd to form, which when churned will not wash out, but remains with the butter. According to several articles I have seen in dairy papers, it would seem that many confound these three terms, viz., mottled or streaky butter, white specks in butter and white flakes. Therefore, as has been stated, mottles are caused by an uneven distribution of salt, white specks are caused by a curd being formed in the cream, and white flakes by dried or flaky cream, the result of cream not being properly stirred.

Another point well worth every creameryman's attention is to be on guard when the cream is brought in, and see if there is any that is not all right, and if such should be the case, then keep such a can by itself and churn it separately, and not spoil a whole churning. It is very essential that a butter-maker should have a keen sense of smell as well as taste, for these senses will be brought into use often, if one is as particular as he ought to be. One cannot be styled a successful butter-maker unless he is interested in the actual welfare of the creamery as though it was his own business, and spends his energies to that end in the manufacture of the butter and in building up a first-class and permanent trade.

To sum it all up, for one to be practical and successful in the art of butter-making, one must take a special interest in the work, possess a good amount of sense and judgment, be patient, systematic, orderly, neat, and have keen senses.

The CHAIRMAN. We have with us to-day a gentleman from the eastern part of the State, who is or should be well known. He is Mr. N. I. BOWDITCH, Millwood Farm, Framingham.

Making Milk for Private Trade.

BY MR. N. I. BOWDITCH, FRAMINGHAM.

Secretary Sessions asked me to talk to you a few minutes about making milk for Boston private trade. I do not mean private family trade, but private hospitals, which use from 100 to 450 quarts daily, where clean milk from tuberculin-tested cows is demanded.

I have only been in the business for the past three years, but have found out a few things that are very essential, the most important of which is to acknowledge to one's self that one does not know everything, and that there is something new to be learned every day about milk raising.

I will endeavor to tell you, in the few minutes allowed me, what I have determined, up to the present time, are the best ways of raising and caring for milk. I do not claim they are better than the methods of others, but they have proved most satisfactory to me. In buying the cow, I want a cow with all the good dairy points, and a good large frame, so she will make good-sized beef when she gets through the mill, as I force my cows all they will stand.

I have much better results buying springers or cows due to calve in four months than I do buying new-milch ones, unless they be from my neighbors; for, if they are left on the cars and become "bagged," it gives them a set-back they do not get over until they come in fresh next time. Then, again, springers are cheaper, and it does not cost much to keep them at pasture or on ensilage, according to the season of the year. As soon as the cow calves I make it an iron-clad rule to give her a dose of epsom salts (from one and one-quarter to two pounds, according to her size), simply as a precaution against milk fever, and after the fifth milking, she is put in the string, if all right in every way. She is then fed very sparingly for ten days, after which she is given

a few shorts daily, until at the end of eighteen days she can have the regular grain mixture, but not her full ration by any means.

I make up my grain ration as follows: 125 pounds Buffalo gluten, 200 pounds winter bran, 80 pounds old-process oil meal. Of this mixture I give a cow from 8 to 14 pounds daily in two feeds, according to her power of assimilation. The average weight of my cows is about 1,250 pounds, and the above ration is too rich in carbohydrates and fat, according to the standard grain rations that are made up; but, not being a chemist, I can only say, come and look at the cows and also the milk record, which is kept on weekly sheets and copied into a large book, so I can tell at a glance what each cow is doing by the week, month and year.

In the barn of 42 head the average daily grain ration is 11 pounds per cow. The gluten costs, per ton, $13.50; the shorts cost, per ton, $12.50; the oil meal costs, per ton, $17. My daily grain ration costs only 7 cents per cow.

In addition to grain, they have 35 pounds of ensilage daily, divided in two feeds, also two feeds of hay of 3 pounds each, or oat straw. My ensilage I sell to the cows at $2 per ton and hay at $16 per ton.

The cost of feed per day for one cow is: Grain, 7 cents; ensilage, 3 cents; hay, 8 cents; total, 18 cents. Add to cost of feeding the care of cows, grooming, milking, care of milk, washing cans and taking milk to depot, etc., which is 8 cents per day per cow, or total of 26 cents per day per cow.

I find by feeding the above ration that the cows will give me a larger yield of milk and at the same time put on flesh, so that they can be turned for beef at any time, and bring nearly enough to buy a new one.

I have one cow that has been through the mill for three years now, and for the last two years she has paid me gross over $200 yearly in milk alone, and this year she has started in to beat all previous records.

At present the barn of 42 head averages 27 pounds daily, mixed milk tests 4.3, and they are made up as follows: 14 calved within two months, 23 calved six months ago, 5 have been milking from one year to a year and a half. If at any

time a cow is not paying her way, she is sold at once to the butcher for what she will bring.

Another point in keeping cows up to their milk is by giving them water warmed to a temperature of 65 to 70 degrees in cold weather. This was very forcibly brought to my notice last winter, when my boiler broke down, and each cow dropped from a pint to a pint and a half in her daily milk yield. They will shrink a like amount, too, if, when freshly bedded with sand or sawdust, the same is wet and damp. I am a firm believer in turning them out for an hour or two in the middle of the day during the winter, for exercise. I think it is contrary to all laws of nature to keep them tied up and made a perfect machine of from November to May. It stands to reason that they want a certain amount of moderate exercise to keep up their appetite and keep in healthy condition. I feed them all summer in the barn, but turn them out for four or five hours each day in a lot near by, unless the weather be stormy. A cold north-east storm, while it does not lessen the flow of milk very much, does lessen the butter fat. I have seen it make a difference of two spaces in a Cooley can of milk.

Before taking up the care of the milk, I would like to add that I have about decided not to bother with a cow that does not throw off her after-birth properly, or one that will not carry her calf the full time. When they do not clean properly, they do not do well for a long time, and they are quite apt to drop their next calf before time.

I will sum up the care of the milch cow in the following words, — regularity, cleanliness and gentleness. Milking begins on the minute of ten minutes past five in the morning and twenty minutes of five in the evening. Each cow's udder is brushed clean before milking; and as soon as each cow is milked her milk is taken at once to the milk house, where it is strained through five thicknesses of wire and eight of cloth, then run over a Star cooler and aerator, reducing the temperature to about 50 degrees, into 20-quart cans. These cans as filled are put into a tank of ice water. After all the milk has been cooled it is poured into a big mixing vat and drawn off as rapidly as possible, every fourth can being emptied back, to insure a thorough mixing.

I want to impress on the milk producers present the importance of aerating and cooling the milk, which if properly done will prevent a large amount of sour milk being returned; and any farmer having spring water running in his buildings can do this at a very small cost. As an illustration, I will state that for the last two summers I have sent milk to Boston, which was taken across the city, carried on a train twenty-five miles down the north shore and then in a row boat a mile out to sea. Saturdays I had to send enough to last through Monday, and not one quart of sour milk did they have all summer. You may remember it was quite hot for ten days in August.

I have found out also how I can keep my milk from souring when we have thunder showers. As soon as cooled and aerated, cover tightly and put in ice-water tank, cover with cracked ice fully five inches deep. With my milk packed in this way I have had lightning strike very close to the milk house, with no injurious effect to the milk.

I send my milk by express (each morning) to my customers in sealed or locked cans, and in summer I use jackets on what goes a long distance. Sending in locked cans is a great protection to the milkman, and gives him a chance to find out where the trouble, if any, is with his milk. For example, I had been shipping milk to an institution for a while, when I received a letter from the matron, saying the milk was so dirty that when poured from a white pitcher it left the sides all dirt. As I used every effort to have the milk leave the farm perfectly clean, I made a little investigation, and found that the man who supplied them before they used *tested milk* had a cousin still working in the kitchen, and she was putting a handful of sand into every twenty quarts of milk.

I want to impress on every milk producer present the necessity of being regular, gentle and clean in all his barn work, without which he cannot be a success. Keep a careful record of each cow's daily yield, and at the end of the month he can tell where he stands. Do not do what a farmer I know was doing last winter. He kept three cows, only one of which was giving milk; he sold one can daily, for twenty-seven cents at the door. That was all the ready money he

had coming in, except when he got a day's work. One day when talking with him I asked him how he fed this cow. He told me, and I was so astonished I took her daily ration and weighed it, and found it cost him over thirty-three cents daily to keep the cow. His only remark when I showed him the error of his ways was, "Well, by gosh, I can't see her starve." The scales are the milkman's weeder. Use them regularly, both for what you feed the cow and also for her yield at the pail.

I have only been a milk producer for a few years, but I hope that what few conclusions I have come to I have made clear to you all.

The CHAIRMAN. The meeting is open for any questions or for discussion. These gentlemen will be glad to answer any question that you may ask.

Mr. LYMAN. I want to speak of one thing. I found a piece in an agricultural paper in regard to working salt into butter with a ladle. It is certain that no one can make first-class butter in that way. The butter should come in kernels; draw off the buttermilk, put in the salt, wash it and take it out of the churn.

Mr. GOVE. Wouldn't you have to work it with a ladle then?

Mr. LYMAN. No; it is not touched with a ladle at all.

The CHAIRMAN. I would like to inquire of Major Alvord what would be the best method of salting butter?

Major ALVORD. I do not think one person's opinion ought to weigh anything with the success of experienced men. If different persons pursue different processes and arrive at the same satisfactory results, I see no reason why one should adopt the methods used by the other. I think the butter when in the form of small kernels is in the most desirable form for salting. I also have rather a prejudiced bias in favor of salting with brine instead of with dry salt, and some of our most successful creameries do not use dry salt at all. They simply wash their butter in a strong brine and pack directly from the churn, and only that amount of salt goes into the butter that the spaces in the butter as packed give place for brine.

Secretary SESSIONS. Do you think the addition of salt to the washing water is a help in ridding the butter of the buttermilk.

Mr. LYMAN. I have an idea that it is. I cannot tell from experience. I have heard it recommended a great many times.

Major ALVORD. In experiments made by myself a number of years ago (I have had no experience lately) we boiled down the water after using when we used clear water, and then we boiled down brine after using when we used brine. I found a great deal more scum on the brine than on the water, showing that in the use of brine we succeeded in getting out of the butter more of the foreign substances (which we want to do when we are making a good article of butter) than in the use of the clear water. That satisfied me at that time.

Mr. GRAY (of Ashfield). As this is an experience meeting, it might be interesting to the audience to hear our experience in heating water. Some half a dozen years ago we commenced to warm the water for the cows. We weighed our butter and salted it by weight. We were obliged to stop warming the water one year in March, when it was as cold as any time in the winter, and we could not see one particle of difference in the quantity of butter when we had to stop right off at once.

Secretary SESSIONS. I should be very glad indeed if Mr. Gray would elaborate a little on his experience in butter-making. He was recommended to me for a paper at this meeting. Two have failed us, and, had I known it in time, I should have asked Mr. Gray to present a paper.

Mr. GRAY. I can simply tell our methods of making butter. We use the De Laval separator. Our cream is stored in what is known as the Eureka milk cooler. In warm weather we run spring water around it to cool the cream. We have it somewhere in the neighborhood of 60 degrees, and churn twice a week. We have the cream at about 60 degrees when it is ripening, but in summer we churn at 56; in the winter, 60 or 62. Our Sunday night's cream is churned Tuesday; our Thursday morning's cream is churned Friday. We churn in a revolving box churn.

Salt, one-half ounce to the pound; let it stand twenty-four hours after salting; work and pack. That is the method.

The CHAIRMAN. Are there any more questions to be asked?

Secretary SESSIONS. I wish Mr. Gray would give his feed for his cows.

Mr. GRAY. I could not tell you the number of pounds. We feed by measure.

Secretary SESSIONS. You feed it yourself, I presume.

Mr. GRAY. Most of it; yes, sir. We measure the grain with an old-fashioned pint basin. In the morning we give two heaping measures of wheat bran, a basin heaping a little with Indian meal and one about level full of cotton-seed. Then we feed a ration of ensilage, — one bushel to two head, as a general thing; some of them get a little more. We have the bushel basket pretty well rounded up. After watering, we feed a ration of hay. They have nothing more until about four o'clock. Then we feed a ration of rowen; milk; then we water, and feed the same ration of grain at night. I would say that the last feeding in the morning is a ration of what we call poor hay, — the poorest we cut. At night we feed to our milch cows the same ration of ensilage that we do in the morning, in addition to the rowen. We churn our butter until it is in granules as large as a good-sized pea or bean, so that the buttermilk will run freely; then we turn through a pailful of water at the temperature of about 60 degrees, and rinse out what we can; then put in water and gather it in the water.

Secretary SESSIONS. You do not use any salt?

Mr. GRAY. No, sir.

Secretary SESSIONS. Have you ever tried it?

Mr. GRAY. Never tried it.

Mr. ——. I wash my butter with a weak brine. It separates the buttermilk from the butter and lets the buttermilk run off freely; then wash the butter afterwards.

Mr. LYMAN. We have heard a great deal about white specks and streaks in butter. I think if you wash the butter with brine you get rid of those. When I take my butter out of the churn and put it into the worker there is hardly ever a speck of buttermilk in it, or any discoloration. I

wash it perfectly clean, and never have any trouble. There is not a speck or streak in it.

Secretary SESSIONS. Because you handle it systematically, and do not give it an opportunity to dry onto the cans

Mr. LYMAN. I think likely.

Secretary SESSIONS. It makes a great difference if you attend to these things from first to last.

Mr. GRAY. We have no trouble with white specks; never did.

Secretary SESSIONS. White specks come from negligence, in my experience.

Mr. LYMAN. I used to handle a great deal of butter that had streaks and specks in it. Since creameries have been established that has gone out.

In speaking of the firmness and hardness of butter, I think cream raised in the old-fashioned way and skimmed off from pans makes a firmer, harder butter, and that it will stand more heat than that raised in separator or by cold storage.

Mr. W. H. GOVE (of Blackinton.) That is my experience. I use small pans. I find that it makes better butter, and, as Mr. Lyman stated, two pounds of my butter seems to go about as far as three pounds of creamery butter. I have customers that I have had eighteen years. I have some that have tried creamery butter, but have come back. They preferred the farmer's butter.

Mr. LYMAN. I can beat you on that. I have had customers for fifty years.

Mr. GOVE. I use a teacupful of salt to a pail of water, — a ten-quart pail. That washes the buttermilk clear from the butter. The butter will rise and let the buttermilk off freely.

Mr. GRAY. I would like to have Mr. Alvord talk about that milking machine.

Major ALVORD. I am afraid it would be what might be termed "previousness" to say too much about the milking machine. Let me say that there is nothing that can ensure cleaner milking and purity of dairy products than the milking machine which shall carry the milk in a closed receptacle, without exposure to the air, especially in the case of large

herds, where hired milkers have to be employed. I think it is a fact that the mechanical cow milker is almost in sight. Perhaps I said "in sight," this morning. If I did, I will stick to it, and say that I think the successful mechanical cow milker is in sight. I would rather stop there as far as my record goes for 1896.

They cost from one hundred and fifty to two hundred dollars for a machine to milk one hundred cows. You can get a machine that will milk ten cows, but it would not make very much difference in the cost. One hundred and fifty dollars pays the expense of putting the machine up. Some parts of them are fixed in the stable, and do not have to be moved after they are once put in.

Adjourned at 3.30 P.M.

ANNUAL MEETING

OF THE

BOARD OF AGRICULTURE

AT BOSTON.

JANUARY 12 AND 13, 1897.

ANNUAL MEETING.

In accordance with the provisions of Chapter IV. of the by-laws, as amended by vote of the Board at the special meeting at Greenfield, the Board met at the office of the secretary, in Boston, on Tuesday, Jan. 12, 1897, at 12 M., it being the Tuesday preceding the second Wednesday of January. In the absence of the Governor and First Vice-president GRINNELL, the Board was called to order by the second vice-president, Mr. FRANCIS H. APPLETON.

Present: Messrs. F. H. Appleton, J. S. Appleton, Jr., Avery, Blair, Bourne, Brewster, Bursley, Clark, Clemence, Cook, Cruickshanks, Damon, Ellsworth, Gove, Harwood, Hersey, Horton, Kilbourn, Lyman, Norton, Palmer, Pratt, Raymond, Reed, Sargent, Sessions, Francis Shaw, N. W. Shaw, Smith, Stetson, Taylor, Tucker and Wood.

The records of the special meeting of the Board at Greenfield were read and approved.

The executive committee, by Mr. Wood, chairman, reported the list of qualified members of the Board for 1897. The newly elected members are as follows: —

At large, appointed by the Governor: —
SPRAGUE S. STETSON of Lakeville.

Elected by the societies: —
Amesbury and Salisbury, F. W. SARGENT of Amesbury.
Berkshire, WESLEY B. BARTON of Dalton.
Blackstone Valley, CHAS. E. SEAGRAVE of Uxbridge.
Eastern Hampden, O. P. ALLEN of Palmer.
Hampshire, Franklin and Hampden, EDWARD E. WOOD of Northampton.
Hingham, EDMUND HERSEY of Hingham.
Hoosac Valley, N. B. BAKER of Savoy.
Housatonic, CHARLES B. BENEDICT of Egremont.

Manufacturers' Agricultural, OSCAR S. THAYER of Attleborough.

Marshfield, WALTON HALL of Marshfield.

Massachusetts Horticultural, E. W. WOOD of West Newton.

Massachusetts Society for Promoting Agriculture, FRANCIS SHAW of Wayland.

Nantucket, J. S. APPLETON, Jr., of Nantucket.

Weymouth, QUINCY L. REED of South Weymouth.

Worcester East, W. A. KILBOURN of South Lancaster.

Worcester North-west, to fill out the unexpired term of Mr. A. D. Raymond, T. H. GOODSPEED of Athol Centre.

The committee further reported that the election of a delegate from the Hampden Society was contested, and recommended that the matter of contested seat be postponed until the appearance of both the contestants.

The report of the committee was accepted and adopted.

An abstract of the secretary's report was presented and accepted.

The records of the executive committee, acting for the Board, were read by the secretary and approved, and the actions of the committee were adopted as the actions of the Board.

The committee on forestry, roads and roadside improvements, by Mr. F. H. Appleton, chairman, made verbal report, which report was accepted.

Adjourned to 2 P.M.

Board called to order by Chairman APPLETON at 2 P.M.

An abstract of the reports of inspectors was read by the secretary, copies of the reports having been sent to the several societies interested in accordance with a vote of the Board at the last annual meeting.

Mr. Geo. M. Whitaker, assistant executive officer of the Dairy Bureau, presented and read the annual report of the said Bureau to the Legislature, which report was accepted and adopted, and will be found printed in this volume.

The report of the committee on Agricultural College and education was read by Mr. George Cruickshanks, was discussed, and by vote of the Board was accepted and adopted as the report of the Board to the Legislature. The report will be found printed in this volume.

Voted, That the Board recommend to the Agricultural College that the report of the committee on Agricultural College and education be printed by the college and distributed.

On motion of Mr. Ellsworth, a committee of three was appointed by the Chair to write to Vice-president GRINNELL in behalf of the Board, and express to him its sympathy with him in his illness and its hope for his speedy recovery.

Voted, on motion of Mr. Kilbourn, that it is the opinion of the Board that the committee in charge of the gypsy moth work should provide the members of the Board an opportunity to examine the infested region in the near future.

The secretary stated what had been done in the matter of abandoned farms, and further stated that a new catalogue was in process of preparation and would be issued in the near future.

At 4.40 P.M. the Board adjourned to 9.30 A.M., Wednesday.

SECOND DAY.

The Board met at 9.30 A.M., Mr. APPLETON in the chair.

Present: Messrs. Allen, F. H. Appleton, J. S. Appleton, Jr., Avery, Baker, Barton, Benedict, Blair, Brewster, Bursley, Clemence, Cruickshanks, Damon, Ellsworth, Goodspeed, Hall, Harwood, Hersey, Horton, Kilbourn, Norton, Pratt, Raymond, Reed, Sargent, Seagrave, Sessions, Francis Shaw, N. W. Shaw, Smith, Stetson, Taylor, Thayer, Wellington, E. E. Wood and E. W. Wood.

The records of the first day were read and approved.

The executive committee, as the committee on credentials, reported, in the matter of credential of a member from the Hampden Agricultural Society, that the Attorney-General should be asked as to the legality of votes cast in the election of a member of the Board from that society by authority of proxies from members who were not present.

The report was accepted and adopted, and the secretary and Mr. E. W. Wood were appointed a committee to bring the matter to the attention of the Attorney-General and in the name of the Board ask his opinion.

The committee on agricultural societies, by Mr. Kilbourn, chairman, presented a written report, which was accepted and adopted, and will be found printed in this volume.

Election of officers being in order, ballots were taken, and the elections resulted as follows: —

President, His Excellency the Governor, *ex officio*.
First vice-president, James S. Grinnell of Greenfield.
Second vice-president, Elijah W. Wood of West Newton.
Secretary, William R. Sessions of Hampden.

Mr. Wood took the chair.

Election of specialists being in order, ballots were taken, and the elections resulted as follows: —

Chemist, Dr. C. A. Goessmann of Amherst.
Entomologist, Prof. C. H. Fernald of Amherst.
Botanist and pomologist, Prof. S. T. Maynard of Amherst.
Veterinarian, Prof. James B. Paige of Amherst.
Engineer, Wm. Wheeler of Concord.
Ornithologist, E. H. Forbush of Malden.

The chairman announced the following standing committees (the secretary is by rule of the Board a member *ex officio* of each of the standing committees): —

Executive committee: Messrs. E. W. Wood of West Newton, W. A. Kilbourn of South Lancaster, Isaac Damon of Wayland, D. A. Horton of Northampton, A. C. Varnum of Lowell, Wm. P. Brooks of Amherst and Francis H. Appleton of Peabody.

Committee on agricultural societies: Messrs. W. A. Kilbourn

of South Lancaster, Q. L. Reed of South Weymouth, N. W. Shaw of North Raynham, O. P. Allen of Palmer and N. B. Baker of Savoy.

Committee on domestic animals and sanitation: Messrs. Isaac Damon of Wayland, G. E. Taylor of Shelburne, Francis Shaw of Wayland, F. H. Smith of Ashfield and W. B. Barton of Dalton.

Committee on gypsy moth, insects and birds: Messrs. E. W. Wood of West Newton, Augustus Pratt of North Middleborough, F. W. Sargent of Amesbury, S. S. Stetson of Lakeville and J. G. Avery of Spencer.

Committee on Dairy Bureau and agricultural products: Messrs. D. A. Horton of Northampton, Geo. L. Clemence of Southbridge, J. Lewis Ellsworth of Worcester, C. B. Benedict of Egremont and E. E. Wood of Northampton.

Committee on Agricultural College and education: Messrs. A. C. Varnum of Lowell, Geo. Cruickshanks of Fitchburg, E. A. Harwood of North Brookfield, John Bursley of West Barnstable and C. K. Brewster of Worthington.

Committee on experiments and station work: Messrs. Wm. P. Brooks of Amherst, Edmund Hersey of Hingham, C. M. Blair of Blandford, W. M Wellington of Oxford and Walton Hall of Marshfield.

Committee on forestry, roads and roadside improvements: Messrs. Francis H. Appleton of Peabody, S. M. Raymond of Hinsdale, J. S. Appleton, Jr., of Nantucket, H. G. Norton of West Tisbury and C. E. Seagrave of Uxbridge.

Which appointments were approved by the Board.

Mr. C. B. Lyman read an essay on "The farmer's opportunity," which was accepted and will be found printed in this volume.

Mr. Geo. L. Clemence read an essay on "Cold storage for farm products," which was accepted and will be found printed in this volume.

A petition of the Franklin County Agricultural Society for the approval by the Board of the vote of the society, authorizing a mortgage of the real estate of the society, was read by the secretary.

Voted, To refer the matter to the executive committee, with power to act for the Board after a hearing of the parties interested, due notice of the hearing having been given.

The secretary reported the delinquencies of some of the societies in making required returns, and gave the excuses of the societies therefor.

Voted, That the delinquencies be overlooked, but that the secretary be instructed to notify the societies that the Board must insist on strict conformity to requirements of the law by all the societies.

A communication from Dr. Jabez Fisher of Fitchburg, indorsed by vote of the Worcester North Agricultural Society, was read.

Voted, To refer the communication to a special committee of five, to be appointed by the Chair, said committee to report at the next public winter meeting. The Chair appointed Messrs. Stetson, Cruickshanks, Hersey, Ellsworth and Clemence as the committee.

Voted, That this committee have authority to advertise proposed legislation before the date of the public winter meeting, if it shall be necessary to do so in order to insure its consideration by the next Legislature.

The secretary read a communication from the Hampshire, Franklin and Hampden Agricultural Society, protesting against the change in the organization or manner of election of the members of the Board of Agriculture, which communication was referred to the executive committee.

Adjourned to 2 P.M.

Afternoon Session.

The Board was called to order at 2 P.M., Mr. Wood in the chair.

The hearing on request of the Plymouth County Agricultural Society for approval by the Board of its vote at the annual meeting, Dec. 2, 1896, "That the society authorize its treasurer to mortgage for a term of years the real estate owned by the society for a sum not exceeding six thousand dollars, and that the State Board of Agriculture be requested to approve of said action," being in order, the matter was

heard. It appearing that the society had proceeded in a legal manner, that this hearing had been properly advertised, and no person appearing to object, it was

Voted, To approve the vote of the Plymouth County Agricultural Society as above quoted.

The hearing on the request of the Eastern Hampden Agricultural Society for approval of its vote at a legally called meeting, Dec. 1, 1896, "To mortgage the society's real estate to the Palmer Savings Bank for the sum of three thousand and sixty dollars," being in order, the matter was heard. It appearing that the society had proceeded in a legal manner, that this hearing had been properly advertised, and no person appearing to object, it was

Voted, To approve the vote of the Eastern Hampden Agricultural Society as above quoted.

The committee on agricultural societies, by Mr. Kilbourn, chairman, reported recommending that the date for the commencement of the fair of the Barnstable County Agricultural society be changed to the Tuesday preceding the first Monday in September; that of the Marshfield Agricultural and Horticultural Society to the second Wednesday preceding the first Monday in September; that of the Hoosac Valley Agricultural Society to the third Wednesday after the first Monday in September; that of the Manufacturers' Agricultural Society of North Attleborough to the Tuesday preceding the first Monday in September; and that the dates of the other societies remain unchanged.

Voted, To accept and adopt the report of the committee, and to change the dates as recommended.

Mr. Kilbourn, for the same committee, reported recommending the assignment of inspectors, as follows: —

Amesbury and Salisbury, at Amesbury, September 28, 29 and 30,	N. W. Shaw.
Barnstable County, at Barnstable, August 31, September 1 and 2,	W. B. Barton.
Berkshire, at Pittsfield, September 14, 15, and 16,	F. H. Appleton.
Blackstone Valley, at Uxbridge, September 28 and 29,	Geo. E. Taylor.

Bristol County, at Taunton, September 21, 22 and 23,	S. M. Raymond.
Deerfield Valley, at Charlemont, September 16 and 17,	F. W. Sargent.
Eastern Hampden, at Palmer, September 21 and 22,	W. P. Brooks.
Essex, at Peabody, September 21, 22 and 23,	D. A. Horton.
Franklin County, at Greenfield, September 23 and 24,	J. S. Appleton, Jr.
Hampden, at ———, September 23 and 24,	C. B. Benedict.
Hampshire, at Amherst, September 28 and 29,	John Bursley.
Hampshire, Franklin and Hampden, at Northampton, October 6 and 7,	Francis Shaw.
Highland, at Middlefield, September 8 and 9,	Isaac Damon.
Hillside, at Cummington, September 28 and 29,	J. L. Ellsworth.
Hingham, at Hingham, September 28 and 29,	H. G. Norton.
Hoosac Valley, at North Adams, September 22 and 23,	Augustus Pratt.
Housatonic, at Great Barrington, September 29 and 30,	Geo. L. Clemence.
Manufacturers' Agricultural, at North Attleborough, August 31 and September 1,	T. H. Goodspeed.
Marshfield, at Marshfield, August 25, 26 and 27,	O. P. Allen.
Martha's Vineyard, at West Tisbury, September 21 and 22.	C. M. Blair.
Massachusetts Horticultural, at Boston, September 30 and October 1,	Geo. Cruickshanks.
Middlesex North, at Lowell, September 16, 17 and 18,	Walton Hall.
Middlesex South, at Framingham, September 14, 15 and 16,	S. S. Stetson.
Nantucket, at Nantucket, September 1 and 2,	F. H. Smith.
Oxford, at Oxford, September 21 and 22,	O. S. Thayer.
Plymouth County, at Bridgewater, September 15, 16 and 17,	J. G. Avery.
Spencer, at Spencer, September 23 and 24,	W. A. Kilbourn.
Union, at Blandford, September 15, 16 and 17,	E. A. Harwood.
Weymouth, at South Weymouth, September 23, 24 and 25,	W. M. Wellington.
Worcester, at Worcester, Aug. 31 and Sept. 1–3,	Edmund Hersey.
Worcester East, at Lancaster, September 16 and 17,	Q. L. Reed.
Worcester North, at Fitchburg, September 21 and 22,	C. K. Brewster.
Worcester North-west, at Athol, October 5 and 6,	N. B. Baker.
Worcester South, at Sturbridge, September 16 and 17,	E. W. Wood.
Worcester County West, at Barre, September 30 and October 1,	E. E. Wood.

Voted, To accept and adopt the report and assign the inspectors as recommended.

The committee on Agricultural College and education, by Mr. Cruickshanks, reported recommending that the next public winter meeting be held at Taunton on invitation of the Bristol County Agricultural Society.

Voted, To accept the report, and that the next public winter meeting be held at Taunton, Dec. 7, 8 and 9, 1897.

Voted, That the chair appoint a local committee of arrangements, to act with the secretary and the committee on Agricultural College and education, to consist of five members. The Chair appointed Messrs. N. W. Shaw, S. S. Stetson, Augustus Pratt, Q. L. Reed and O. S. Thayer as the local committee on arrangements.

Mr. Cruickshanks, for the same committee, reported recommending that Messrs. Sargent and Barton be appointed to present essays at the next annual meeting of the Board.

Voted, To accept the report, and that Messrs. Sargent and Barton be appointed essayists. The gentlemen announced their subjects as follows: "Farmers' institutes," Mr. F. W. Sargent; "Opportunities of New England farmers," Mr. W. B. Barton.

Voted, That the matter of contested election of member of the Board from the Hampden Agricultural Society be referred to the executive committee, with power to act for the Board, when the opinion of the Attorney-General on legality of the election shall be received.

Voted, That the action of the Board taken at the public winter meeting at Dalton in December, 1895, on the matter of tuberculosis among neat cattle, is in accordance with the present opinion of the Board on that subject.

Voted, That the two bills presented to the Board for the regulation of the sale of concentrated feed stuffs, which were prepared by Dr. J. B. Lindsey of the Hatch Experiment

Station, at the request of the Board, be referred to the executive committee, with power to adopt a bill to be presented to the Legislature, after consultation with Dr. Lindsey.

Voted, That the thanks of the Board be presented Vice-presidents Appleton and Wood for the able, impartial and agreeable manner in which they have presided over the deliberations of the Board.

The records of this day's meeting were read and approved.

Adjourned at 5 P.M.

WILLIAM R. SESSIONS,
Secretary.

Report to the Legislature of the State Board of Agriculture, acting as Overseers of the Massachusetts Agricultural College.

[P. S., Chap. 20, Sect. 5, adopted by the Board, Jan. 12, 1897.]

To the State Board of Agriculture, Overseers of the Massachusetts Agricultural College.

The committee on Agricultural College and education, appointed by this Board, are required, among other duties, by the by-laws of the Board, "to visit the college from time to time, to inspect the property, observe the methods, extent and character of the instruction there given, attend the commencement exercises and examinations, and make report of their doings and observations to the Board, with any suggestions and recommendations they may deem proper, as prescribed by the Governor and Council." In compliance with our duty we beg leave to submit the following report.

A part of our committee visited the college Saturday, June 13, and awarded the Grinnell prizes, and were present at the Commencement exercises which followed the next week.

As is already well known, Hon. William Claflin of Boston several years ago gave the sum of $1,000 for the endowment of a first and second prize, to be called the Grinnell agricultural prizes, in honor of his friend, George B. Grinnell of New York. These two prizes are to be paid in cash to the two members of the graduating class who may pass the best written and oral examination in theoretical and practical agriculture. The prizes this year were awarded as follows: Henry Howard Roper, East Hubbardston, first prize; and Henry Ward Moore, Worcester, second prize. But the class as a whole were entitled to much credit for the manner

in which they passed the examination. The faithfulness and earnestness of the instructor, William P. Brooks, professor of agriculture and director of the farm, was manifest throughout all the exercises.

Inspection of the Property.

The requirement to inspect the property of the college has been complied with, and the inspection was done as thoroughly and carefully as possible for a visiting committee.

The number of acres in the several crops are given as follows: grass, 85; potatoes, 8½; onions, 2¾; carrots, 1; corn for the silo, 25⅓; corn for husking, 6; soja beans, 4; oats and vetch, 2; millet, 4½; celery, 1; mangolds, 1; Swedes, 1¼; horse beans, 1. Hay at the first cutting yielded 144 tons; the second cutting 52 tons; oat and vetch hay, 5½ tons; millet hay, 6 tons; making a total of 207½ tons. In addition to the millet made into hay, 40 tons was put into the silo. Of other crops raised for ensilage, the 4 acres of soja beans yielded 41 tons and the 25⅓ acres of corn yielded 280 tons. Although the yield per acre was not large, the corn was well eared.

Celery was grown for the first time last year, and seems well adapted to the soil. One acre on the north flat was planted with the Giant Pascal celery. The cost of production, when packed in the pit, was $98,01; yield, 300 dozen at $1 per dozen, $300; balance in favor of the crop, $201.99.

Potatoes. — But little fertilizer was used on this crop, 200 pounds per acre being the limit. The yield was 1,041 bushels large potatoes and 273 bushels small potatoes. The average per acre was greatly reduced, owing to low, wet places in the field, which have not yet been fully underdrained. The Robbins potato planter was used this year for the first time, and gave excellent satisfaction.

Horse Beans. — These were planted in drills 18 inches apart, with 6 to 8 seeds to each foot of row. They were cut and fed green by the first of August, and yielded 5 tons, or 1,541 pounds per acre.

The land on which the onions, carrots and mangolds were planted proved too wet and cold to produce good crops.

Corn, millet and soja beans were grown on the twenty-four acres on the campus slope. Four acres on the old barn site were seeded down in August. The grass made a good stand, and bids fair to produce a good crop next year.

Live Stock.

There are 13 horses, 76 head of neat stock, 41 Southdown sheep and 11 swine.

Tools and Machinery.

The tools and all of the machinery used upon the farm were found in good condition, and well adapted to the uses required of them.

Improvements.

Most of the work in improvements the past year has been in fencing the lot which was cleared last season. This required a trifle over one mile of barbed-wire fence. In addition to this, a lane 1,460 feet long has been made, leading from the barn to the pasture. The fence used for this purpose was the Page woven wire.

Property and Equipment.

The area of the college land is 401 acres, valued at $45,500, 17 acres being the newly acquired Clark property; the cost of the Clark property being $4,500. The principal college buildings are eight in number, valued at $264,340. The value of other equipment is $67,188.67. The amount of all endowment funds is $360,575.35. The college buildings are situated about one mile north of the town of Amherst, the location being very beautiful, commanding one of the finest views in Massachusetts.

Instruction.

As to the methods, extent and character of the instruction given at the college, the committee takes pleasure in saying that its high standing is fully sustained. Gentlemen who have paid much attention to the study of scientific agriculture speak of the methods, extent and character of the in-

stitution in the highest terms. It can hardly be otherwise. President Goodell, as well as his faithful corps of assistants in the various departments of the institution, is fully alive to the importance of the work, and leaves nothing undone that would forward the interests of the institution. The college is fully entitled to the credit of another year of successful achievement under its excellent management.

The regular course of study occupies four years, and those completing the course are entitled to the degree of Bachelor of Science. In the senior year all the studies are elective, except English and military science. This enables the older students to select those studies which they may think will be the most useful to them in the future. Important changes have been made in the curriculum. Latin as a requirement for entrance and as a required study has been dropped.*

There was until recently a two-years' course, but it was discontinued by the trustees Dec. 31, 1895, and short winter courses established after the closing of the (then) current collegiate year. The studies in these short courses are agriculture, botany, chemistry, dairying, floriculture, horticulture, market gardening and zoölogy. Examinations for these courses are not required, and the doors are open to applicants of both sexes, but candidates must be at least sixteen years of age.

Scholarships.

In 1878 the trustees voted to establish one free scholarship for each of the congressional districts of the State. Applicants should enter college with the intention of remaining through the course. In addition to these scholarships, the State has, by act of the Legislature, established eighty free scholarships, two for each senatorial district, which may be obtained by application to the senators representing the various districts in the Legislature.

Labor Fund.

For the benefit of students dependent largely upon their own exertions, the State has established by act of the Legislature, and maintained by annual appropriations, a fund of

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* Trustees' report, page 8.

$5,000 per year, which may be expended for labor, and a student requiring aid may pay a considerable part of his college expenses in this way.

Other Funds.

Several philanthropic persons have also established funds for worthy students requiring aid. There is the Mary Robinson fund of $1,000, the Whiting Street fund of $1,000 and the Henry Gassett fund of $1,000.

The Experiment Stations.

In 1882 the State Experiment Station, so called, was established by an act of the Massachusetts Legislature. The Hatch Experiment Station was established by an act of Congress, Feb. 25, 1887. The State Experiment Station and the Hatch Experiment Station are now consolidated by an act of the Legislature, under the name and style of the Hatch Experiment Station of the Massachusetts Agricultural College.

The work of the consolidated stations has been conducted in much the same manner as in previous years. At the time of your committee's visit, in August, the different varieties of millet (seventeen in number) were about mature, and presented a very interesting exhibit. Eighty varieties of potatoes and twenty-eight of corn were grown in this department. At the barn of the department of foods and feeding, in charge of Dr. J. B. Lindsey, experiments are being conducted in feeding milch cows different samples of salt and meadow hays, obtained from near the sea shore, to test their value, as compared with English or upland hay. A large wing has been added to the main experiment station building, furnishing much-needed room for the laboratories connected with the same.

Horticultural Department.

The work of this department of the college has during the past season been carried on on lines similar to those of preceding years. The income from the sale of fruit, vegetables, flowers, trees, shrubs and plants has been about the same as

for 1895. The old pear orchard, located east of the vineyard, which was made nearly thirty years ago by planting old trees, not proving satisfactory either for business purposes or for illustration of a perfect orchard, and having been seriously injured by fire blight and the pear tree psylla, was removed root and branch early in the spring. The land occupied by the old peach orchard was also cleared of trees, many of the trees having been planted in 1875. Both these pieces of land are being refitted and improved so as to serve as a place for planting all the new species and varieties of Japanese plums and other stone fruits, as well as the new kinds of apples, pears and cherries as they are introduced. During the past season a large number of new varieties of all the tree fruits have been propagated and purchased, and will be ready to transplant the coming spring. These will make a collection very complete in all the new and desirable varieties.

The Clark Park.

The estate formerly owned by the late lamented president of the college, Col. W. S. Clark, which came into the possession of the college last June, has been assigned to the horticultural department, under the direction of the farm committee of the Board of Trustees. The work of renovation and improvement was begun as soon as possible. The open land, about seven acres at the northern limits, was cleared of fences, spruce and other trees, and ploughed. One and a half tons of muriate of potash and two tons of rock phosphate were applied, and a thick seeding of rye sown, to be turned under in the spring of 1897 for green manuring. In due time this land will be ready for permanent orcharding of all the standard fruits. The white pine hedge between this estate and the college property has been removed, the underbrush cleaned up and the surface smoothed down so as to present an even surface.

Experiment Work of the Department.

The experiment work has been carried on on about the same lines as in former years. In addition to the usual test of named varieties of fruits, there are on the grounds about

five hundred unnamed seedling strawberries, most of which have fruited once; from five hundred to six hundred seedling grapevines, many of which will fruit the coming season; and about three hundred seedling raspberries from carefully selected seed of the Shaffer, a purple cap noted for its great productiveness, but of poor color and not quite hardy in New England. These plants are large enough to produce fruit the coming season, and present a great many different forms of foliage, habits of growth and color of stems. The raspberry plants and grapevines are left fully exposed to the weather, so that their hardiness may be determined. A series of vegetable seed tests were made from seeds obtained from seven of the largest dealers in the country. The test was made in the greenhouse and in the open ground for germination, all under the same conditions, and a careful record made of the result. The purity of the variety or strain was determined in the field at harvesting. The leading varieties of beets, cabbage, cucumbers, celery, lettuce, onions, parsnips, squashes and tomatoes were tested in this way. Full reports of this work, with the results, will be published before spring. Fruit growing is taught by first giving the student a full knowledge of the structure of the plants to be grown, the methods of propagating, pruning, training, cultivating, gathering, packing, storing and selling the same. In market gardening, floriculture and ornamental gardening the same course is pursued. "The main object of the government endowments for these institutions was to foster and build up the science and art of agriculture, the calling which is the basis of all prosperity, and without which the people of the earth would cease to exist."

Physical Features.

In conclusion, we would bring to your attention some physical features of the State college and its attractions. On the easterly side of the Connecticut River, sloping to the westward, lies the farm of the Agricultural College at Amherst, Mass. Its lower part is flat and level, like a river bottom; its central portion is an upland basin. Upon one crest are the agricultural college buildings, upon the

other the horticultural buildings with their pleasant adjuncts, and between is an artificial lake set like a gem of beauty in the attractive surroundings. Farther to the eastward is a high ridge of land and the newly acquired addition known as the Clark property, which is a continuation of the high land upon which Amherst village is located. From this portion of the farm the view is a charming panorama to the lover of nature. To the south are Mount Holyoke and Mount Tom, rising like great sentinels out of the Connecticut valley to guard the landscape in its beauty and watch over, as it were, the colleges of Amherst, Northampton and South Hadley and the seminary at Easthampton, whose fame and influence are as wide as civilization. To the westward lies the bold range of hills, rising to a yet greater altitude than the mountains referred to: the hills of western Hampshire, that the great poet of nature has immortalized in song; the hills where Bryant, Curtis, Norton, Chadwick, Warner, Hall, Dawes and a host of lesser lights in the literary world delighted and delight to spend the summer season, drinking in inspiration to breathe out again in crystallized thought upon a waiting world; the mountains where Bryant wrote his "Thanatopsis" and sang of the rivulet and the forest, —

> "The mountains that infold in their wide sweep,
> The colored landscape round,
> Seem groups of giant kings in purple and gold,
> That guard the enchanted ground" —

while to the north rises Mount Toby, like a great watch tower, sending down its benediction from the northern sky. What more picturesque or charming place could the State, or its trusted officials, have found for the enterprise it commenced in 1863? That this place, with all its inviting features of art and nature, its educational advantages and opportunities, its valuable scientific and experimental work, bringing new light and knowledge upon agricultural subjects, is not fully appreciated and appropriated by the people of the Commonwealth, is the opinion of your committee.

In closing, your committee would make an urgent appeal to every parent and guardian in the Commonwealth that they visit the college, and see for themselves the opportunity it affords their boys for a helpful, practical education at a comparatively small outlay.

Respectfully submitted,

A. C. VARNUM.
GEO. CRUICKSHANKS.
E. A. HARWOOD.
JOHN BURSLEY.
C. K. BREWSTER.

Report of Committee on Agricultural Societies.

[Adopted at the Annual Meeting, Jan. 13, 1897.]

Not without a worthy purpose are our several inspectors appointed to attend the fairs held by societies receiving State bounty, while they have varied, perhaps conflicting, ideas of what a good fair should be, yet by a comparison of these reports we think that any society which held a fair not open to the criticisms made by one or another of these reports would be well-nigh perfect.

The criticisms coming most particularly to the notice of your committee were those on insufficient or uncleanly sanitary arrangements. These we believe to be worthy of special consideration. The grounds of many societies are used only on the occasion of the fair; the number of people in attendance is large, and the sanitary conveniences are wholly insufficient and unsuitable.

The next criticisms are on the class of side shows and catchpennies of doubtful or sometimes quite surely of immoral tendency. These, perhaps without the knowledge of the officers of the society of what the proposed show is to be, obtain admission to the grounds, pay for the space required and hold it till turned off by the police; or possibly, on failure of the police to find anything worthy of expulsion, stay through, to the injury of the good name of the society and the great regret of all better minded persons. These can only be shut off by prompt refusal of entrance upon the grounds or of location in the neighborhood to all shows or fakirs against whom there is suspicion, and by prompt removal if they happen to gain entrance. Among these your committee would include all shows open to men only or to women only, all distributors of bad literature, and all those

that by a somewhat liberal use of the term could be called gambling devices. Your committee believe that all these should be eliminated, and that it is the clear duty of inspectors to report the facts wherever such violations of the intent of the State law are found.

In different parts of the State fairs of different kinds are held, one making prominent the cattle, another the fruit and vegetable department, another holding or proposing to hold several shows in the course of the year, thereby complying with the law, if they pay out in the course of the year the six hundred dollars in premiums, provided they meet the other conditions on which the bounty is to be paid:

Another condition of the law, where money once contributed and held for the purposes of the society has been lost, or the property representing it has been depreciated or encumbered, should not be disregarded. It would seem that where the property owned by the society is less than three thousand dollars the bounty claimed should be proportionately less. Your committee believe that the best interest of the societies would be served by such diminution of the bounty, compelling in some cases a *bona-fide* contribution of new capital or reorganization.

Respectfully submitted,

W. A. KILBOURN.
F. E. CLARK.
W. H. GOVE.
N. W. SHAW.

Cold Storage for Farm Products.

BY MR. GEO. L. CLEMENCE, SOUTHBRIDGE.

A person does not need to be far advanced in years to remember when ice, as a household or farm commodity, was used only to a limited extent and in isolated instances. Scarcely more than two-score years ago the farmer was wont to chill his hay-field drink by depositing pail or jug in some near-by spring or brook, and if neither of these were convenient, his drink was taken at a temperature towards the boiling point, the rays of the summer sun having penetrated through the bushes or grass that covered pail or jug.

Then, also, to keep butter cool it was laid on the cellar bottom, and if it was desired to keep a can of milk over until the next day a string was tied to the handle, and the whole was immersed in the well. What few ice-houses there were in those times were small and primitive affairs, and their construction was almost invariably underground, for to expose the exterior of an ice-house to the open air and sunlight was a plan at once considered wrong in principle. It is also a matter of interest at this time to note that the great mass of people, of thirty-five or forty years ago, smiled at the idea of having a supply of ice in the summer months, and did not recognize its need or economy. But as correct principles of ice-house construction became known, which, with improved methods of gathering the crop, reduced the cost, so that it was within the means of all, ice has come to be an indispensable article in practically every household and upon every farm, in these days of a manifold increase in the needs and demands of human life, as represented, at least, in the New England States.

With the ice-house a success, the family refrigerator followed. Only a few years ago this was scarcely more than a

box, upon which an extra effort had been expended to have it air-tight. Improvements in the style and construction of the common refrigerator followed in quick succession, and its evolution is seen to-day in that system known as cold storage, by means of which we have, in the way of perishable products, all things at all seasons of the year. As an economic measure, the system of cold storage is receiving from the business and commercial world great attention, and, taking the country through, millions of dollars have been employed in the establishment of plants. It is the cold storage room of the average market, the packing house and the wholesale store that enables the owner to keep sound, sweet and free from taint dairy products, eggs, fruit, all kinds of meat and indeed all perishable products. So extensive and general has become the use of ice for the preservation of perishable products that it can be said that in these days no market, grocery or fruit store is without its great refrigerator or cold storage room; and when one realizes the necessity of this provision, the wonder is, how the world ever got along without its ice supply. So great and imperative has become this need of ice, and in such enormous quantities, that, cheap as it is as a commercial commodity, and effectual as it may be in lowering the temperature of a given space, this present-day business life has demanded something still better, and, under certain conditions, still less expensive. As in practically all instances where a real necessity has existed for some improved method to conserve the wants of man, science has devised that better way, so in the case of refrigeration, has science found a means by which man may create cold without the aid of natural causes or influences, and so perfectly and economically that the artificial means is to be preferred, under certain circumstances, to the use of ice, as by these systems a greater degree of cold or refrigeration is secured than is possible with natural ice. The development of these various methods for creating artificial cold or refrigeration has called into use the highest and most abstruse knowledge the world possesses of heat transfers, and the action of compression, expansion and absorption. To give and explain all the details and principles of these different systems is utterly impossible in a paper like

this. Sufficient it must be to simply state the fundamental principles of these several mechanical processes, for such they are in every instance, for producing cold air in a given space.

Artificial refrigeration is produced, first, by transferring heat from a warmer body to a colder one, as refrigeration by cooled brine, which is one of the most practical and common methods in use; second, by the consumption of heat, brought about by mechanical work or action; third, by the evaporation of liquids having a low boiling point. The governing principle in this is that the latent heat of evaporation represents the amount of cold that can be produced in this way. To these mechanical processes for cooling the atmosphere should be added that by melting or dissolving solid bodies, like the melting of a cake of ice, or the solution of salt in water, making a brine.

In practically all refrigerating systems, except that of melting ice, a series of coils of pipes is used. These are called expansion pipes, and those in the brine system are placed in separate tanks containing the brine, which is cooled to the desired degree. The brine, so cooled, is then conducted by means of force pumps through pipes located in the rooms to be cooled. This method of refrigeration is a safe and sure one, though its efficiency may not be so great as that of the vaporization of certain properties.

Perhaps the most generally used of the mechanical processes for refrigeration, except it be the brine system, is that called the ammonia compression system, which may be accomplished either by absorption or direct expansion. The refrigeration in this system is brought about by the evaporation of liquid anhydrous ammonia, which takes place in coils of pipes called the expander, or refrigerating coils. The ammonia occurs in practical refrigeration in three different forms, as the liquid anhydrous ammonia, the gaseous anhydrous ammonia and solutions of ammonia in water of various strengths. Anhydrous ammonia is such as has been wholly freed from water. At 28 degrees below zero it is a vapor or gas, just as water turns into steam or vapor at 212 degrees above zero. At a temperature of 30 degrees below zero ammonia becomes a liquid by the ordinary pressure of

the atmosphere, and at higher temperatures if higher pressures are employed. Anhydrous ammonia dissolves in water in varying proportions, and forms the aqua ammonia of commerce. When the anhydrous liquor is used for refrigeration, it is called the compression system; and when ammonia proper is used, it is styled the absorption system.

In the practical operation of the ammonia compression system the coils of pipes are placed in the rooms to be refrigerated. The ammonia, after having expanded, is compressed again by means of a compression pump, called the compressor, into another system of pipes, called the condenser. The condenser is cooled off by running water, which takes away from the ammonia in the coils the heat which it has acquired through the compression, as well as the heat which it has absorbed while having evaporated in the expander. Owing to both pressure and withdrawal of heat, the ammonia assumes its liquid form again, to pass into the pipes, thus repeating its circulation over and over again, thus embodying a perfect cycle of operations. Refrigeration by the expansion or volatilization of the liquid ammonia is accomplished to an astonishing degree, as it also is by the brine system. It is possible to run the temperature down to 16 and more degrees below zero, and to freeze solid, meat, poultry, butter or whatever else it is desired to keep for an indefinite time. As these systems of artificial refrigeration require power, and as this power must be kept in operation all of the twenty-four hours in the day, the location of such plants is not everywhere practicable. But the threading of the highway with the electric wire and the increasing adaptability of the gas engine make more and more possible the use of these extremely efficient means of artificial refrigeration.

The use of ice in cold-storage depots is yet by far the most common means for refrigeration, and for ordinary cold-storage purposes it will doubtless so remain for years to come. In cities where great quantities of all kinds of farm products are held for a better market, or to retard the ripening process, or to prevent a high temperature from injuring them, cold-storage plants are oftentimes huge buildings of elaborate construction. Many if not most of these have been built as investments, their owners renting space therein,

or charging a specified sum for the storing of certain articles. The rapid increase in the number of cold-storage depots in all the cities of New England would seem to indicate that the investments are profitable ones, and at the same time dealers in farm produce have found the practice of storing goods a paying one. These owners and lessees of cold-storage rooms and buildings take advantage of the markets, buying when the supply exceeds the demand, and selling when the demand is greater than the supply. Traders and merchants have seen their opportunity in cold-storage, and have made fortunes; for the cost of holding stocks in cold-storage is slight, and the advances in the prices of farm commodities are oftentimes quick and comparatively large.

Take the matter of butter alone: there were held in cold-storage in the single city of Boston, on December 19 last, a total of 103,000 tubs. Allowing that the average weight of these tubs was 20 pounds, makes a total of 2,060,000 pounds of butter. A presumably fair estimate of the price at which this butter was bought in the months of June, July and August is 14 cents. It is also fair to presume that 2 cents a pound paid all costs of cold-storage, as the charges are rarely one-third of a cent a month per pound. But, to make the charge high enough, let it be called 3 cents, and there would be a total cost of the butter on December 19 of 17 cents a pound. Now, the strictly wholesale price of butter in the Boston market, on this same 19th of December, was 21 cents, and it was off a cent and a half from the week previous. This gain of 4 cents per pound on 2,060,000 pounds makes a total of $82,400. But none of this gain went to the farmers of New England, who made this butter and sold it at a figure that hardly gave them a new dollar for an old one. Again, this total of 103,000 tubs in cold-storage December 19 in the city of Boston alone did not represent the entire amount that had been stored during the preceding season, for in the week preceding the stock had been reduced by 11,400 tubs. It is probably safe to say that the net gain in the value of butter placed in Boston cold-storage houses equals, if it does not exceed, $100,000, — a sum which, if divided among the New England dairy farms, would help at least to pay the taxes upon them.

The trader and merchant have been quick to see and improve the opportunities of cold-storage. Why should not the farmer? The plan is in every way practicable. Let even a considerable number of the dairy communities throughout New England have their cold-storage depots, and there will be no glutting of the market with the rich and sweet June-made butter, for the farmers will then be the masters of the situation. It is the surplus tub of butter, the surplus barrel of apples and the surplus hundred-weight of cabbage that makes the price for the whole. The gain from these neighborhood cold-storage houses would be immediate, for, with no surplus stocks of butter offering in June, July and August, the farmer will and must get an enhanced price for the butter he chooses to sell in those months. This would be simply a law of trade. A co-operative cold-storage house can be easily made a part of a co-operative creamery or cheese factory. Such a house can be built at a comparatively small expense, and in practically every neighborhood and village of New England there is opportunity to gather a crop of ice. Ice can be cut and hauled a mile at a cost of not over 25 cents a ton. Such a house should contain two or more compartments, for butter should be kept separate from all other commodities, and, besides, it requires to be kept at a lower temperature than most other kinds of produce. A temperature of 33 degrees will keep your surplus stock of summer and fall apples, in case of an over supply in the market, in fine condition for weeks. Strawberries, raspberries and all kinds of fresh berries can be kept for days at a temperature ranging from 36 to 40 degrees, celery at 35 degrees; cranberries, 34 to 36 degrees; grapes, 36 to 38 degrees; peaches, 45 to 55 degrees; pears, 34 to 36 degrees; onions, 34 to 40 degrees; potatoes, 36 to 40 degrees; asparagus, 34 degrees; cabbage, 34 degrees; maple syrup or sugar, 40 to 45 degrees; honey, 45 degrees; buckwheat, flour, corn meal, oat meal and wheat flour, all at 40 degrees. Butter is preserved both ways: by keeping it at the ordinary cold-storage temperatures of 32 to 34 degrees, or by freezing. It is claimed that the best results come from freezing solid, as the fresh and original flavor of the butter is kept intact. But, be this as it may, the great mass of butter in cold stor-

age is kept at the present time with ice as the refrigerant. Butter to be frozen solid and so kept requires a temperature 10 or 12 degrees below the freezing point. The thawing-out process is allowed in a natural way, and it is further claimed that the thawing develops the flavor.

In most cold-storage houses the refrigeration of the butter room is kept down to, and even 2 degrees below, the freezing point, by using salt upon ice, thereby greatly hastening the melting process. The ice and salt are packed in galvanized iron cans or tanks, each in the series being connected with a pipe. The cans are anywhere from 4 to 8 feet deep, and of sufficient dimensions to take in an ordinary-sized cake of ice. In the hottest of weather these cans and connecting pipes are covered with frost, and experience shows that butter at a temperature of 32 degrees does not lose any marked amount of goodness. The best temperature for the storage of cheese is generally considered 32 to 33 degrees, and should not vary more than 1 degree. Care should be taken not to subject cheese to a high temperature before placing in cold-storage.

It is in such a room as is described for butter, that poultry, game and fish are kept until such time as wanted. The temperatures best adapted for the storage of various kinds of meat are as follows: brined meats, 35 to 40 degrees; fresh beef, 37 to 39 degrees; dried beef, 36 to 45 degrees; hams, ribs and shoulders (not brined), 30 to 35 degrees; hogs, 30 to 33 degrees; eggs, 33 to 35 degrees; lard, 34 to 45 degrees; mutton, 32 to 36 degrees; veal, 32 to 36 degrees. All these temperatures are at or above the freezing point, and thus the meats are sure to retain all their palatable properties and merchantable qualities.

The construction and maintenance of a cold storage house is practicable upon every farm, and the first cost need not be large. There are various plans and methods. One that I have in mind comprehends an unused bent in some wagon shed, barn, cellar or of any farm building. In the arrangement of this, two compartments or rooms should be provided, one for ice, the other for merchandise or commodities. The method of construction should be after the manner of an ice-house, making the insulation as perfect and thorough as pos-

sible. The floor of the ice compartment should receive most careful attention, and the rules here stated should govern all ice-house construction; first, after levelling the ground, lay a floor two inches above the ground, so that here may be the first air space. An inch or an inch and a half above this lay a second floor, and four inches above this lay a third floor, and have it pitch toward the centre, the centre or gutter rising an inch above the second floor. Cover this third floor with galvanized sheet iron, the cost of which is not very much at the present time. Above this dishing floor lay another, of two or three inch wide slats, and upon these place the ice. The water of the melting ice falling upon the sheet-metal floor should be taken from the building through a lead pipe, and this should empty into a tub of water. Keep the outlet or mouth of the pipe always under water, so as to prevent air entering underneath the ice.

The partition between the compartments should be a double one, with an inch and a half air space, to prevent the absorption of moisture. At the top and bottom of this partition there should be spaces for circulation. These spaces should extend the entire length of the partition, and be so arranged as to open when cold air is wanted in the storage room, and to close when such cold air is not wanted.

One hundred dollars will go a long way toward defraying the expense of such a house as is above outlined.

The ventilation of a cold-storage room, be it large or small, is effected by the opening of doors or windows, and by ventilating shafts placed in the ceiling. Where practicable an electric fan is a speedy and efficient method.

A modification of the above-described combined ice-house and cold-storage room may be had by the construction of the ice-house on the outside of a barn or other building, with space opening into a cold-storage room in a barn or other cellar. The cold-storage houses of cities are, as a rule, built of brick, and exceptionally strong throughout, to support the great weight of ice needed for refrigeration. A house that takes 300 tons of ice at a time on its top floor has walls, as a rule, that are 20 inches thick, with a foot more of air spaces, divided as may be into three or four such spaces. Where brine or ammonia is the refrigerant, such strength is

not called for, but the same care as to insulation is observed. Again, most cold-storage rooms, like market refrigerators, have the ice room above the storage room, the weight of the cold air sending it down and around the storing room.

My own experience with cold-storage covers a period of three years, and this feature of my farm operations has been a gratifying success, paying handsomely on the investments of money, time and labor. My cold-storage room occupies a portion of the cellar of my hay barn. It is 30 feet long, 20 feet wide and 9 feet high. The insulation is secured by lining the entire room with dry sawdust, 12 inches thick. The floor is cement, with gutter or drain around the sides. The ceiling is sheathed, and on this is laid 6 inches of sawdust. The circulating space around the body of ice is 4 inches. The ice room is overhead, and is 12 feet wide by 30 feet long, and has a capacity of 20 tons of ice at a time. It requires filling twice a year, the first time when harvesting my general crop of ice, and again in September.

My principal use of this cold-storage room has been to keep cabbages in, from the date of harvesting until spring, or until there was a paying market for them. There is scarcely any shrinkage in the weight of cabbages kept in cold-storage, and, besides the increased price I have been enabled to secure by holding them, I have secured also a time for marketing them when work is not so pressing as in the fall months. This past season I stored for a time my early winter apples, and still later my celery, and both to advantage.

The cost of constructing and maintaining a co-operative cold-storage depot in the average New England farming town or neighborhood would be far less than in a city, and the expense of keeping butter in cold-storage for four or five months would not exceed a cent a pound, instead of the two cents allowed elsewhere in this paper for the cost of cold-storage in a city depot. Oftentimes it is this cent, or two cents, on a pound of butter or poultry, five cents on a barrel of apples or bushel of pears or crate of berries, that determines the profit or loss in a year's farm operations. With cold-storage at their command, the farmers can control the markets to a great extent, whereas now the conditions of the

market control them. The farmers, freed from the necessity of rushing their produce into the market, can possibly arrange some way of getting clear of the commission merchant and the wholesaler, thus coming a step nearer the consumer. Everywhere in the land the manufacturer of cotton and woollen goods, of boots and shoes, of machinery and implements, is dispensing with the jobber and wholesaler. That is just what the farmer wants to do. He wants to stop selling his butter to those men who take it from him with one hand at 14 or 15 cents, and pass it to the consumer with the other hand, at an advance of 8 or 10 cents a pound. He wants to cease selling his poultry for 12 or 14 cents a pound, while the trader sells it the next minute for 20 to 23 cents a pound; and he wants to stop selling his cabbages at 50 cents per hundred-weight to the man who passes them to the consumer at 2 cents a pound, or an advance of 300 per cent. Cold-storage and its possibilities will greatly help to this end. Co-operation among farmers should be made the most of, and this unity of action should comprehend the entire farming community of the country. Cold-storage supplies are now regarded by banks as good collateral security, and by this means the farmer in need of ready money need not make a forced sale of his products. Indeed, this is one of the best features of the cold-storage system. Everybody in business, farmers and all, at times require ready money. In the case of farmers, to get this oftentimes requires a sale at a sacrifice, but with the necessary proof of butter, eggs and fruit in cold-storage, he can obtain a loan as easily as can be done on regular securities.

As to the building of cold-storage warehouses, locality and conditions will determine their size and cost. It may be well to state here that "on an average 40 cubic feet of space is required for 2,000 pounds of ice. The window cases for lighting the storage room should be fitted for three or four sashes, and these should have air spaces between them. A strong and well-insulated wall of wood may be constructed by placing 2 by 6 inch studs, 24 inches apart. In order to form the outside of the wall, nail on the studs first a layer of one-inch matched boards, then a layer of two-ply paper, and again a layer of one-inch matched boards.

Toward the inside a layer of one-inch matched boards is nailed on the studs, and against these boards 2 by 2 inch studs are placed 24 inches apart. In order to form the inside of the wall, one layer of one-inch matched boards is nailed on the 2 by 2 inch studding, then a layer of two-ply paper, and lastly another layer of one-inch matched boards on top of this paper. The spaces left between the 2 by 2 inch studs are left as air spaces, while the spaces between the 2 by 6 inch studs are filled in with shavings."

As to the organization of a co-operative cold-storage company, it can be done upon the same lines as that of a co-operative creamery company, or any other business enterprise. That a large capital is not required to establish a plant in the average New England town is plainly obvious.

With a co-operative cold-storage warehouse once established, its patrons would doubtless find its practical worth and advantage even greater than is now apparent. If any among the owners should wish to store articles that are not for others to handle, this end can be secured by building a cupboard or cabinet of inch wide strips or slats. Place these one-half inch apart, and let the top, bottom shelves and door be made of like inch wide strips. This cupboard, if placed on castors, can be moved easily at will, and can be placed under lock and key. In it can be placed a great amount of farm produce, allowing such cupboard to be 7 feet high, 5 feet wide and 2 feet deep. As the cupboard is open on all its sides, top and bottom and shelves, the cold air would circulate around all its contents.

The same idea as is represented in the construction of the cupboard can be utilized in the making of crates or boxes for eggs. The open-work of such would allow of a free circulation of air, and, as the boxes had better not be over 16 inches deep, they could be packed one above the other, by which method there would be a maximum economy of room.

Every farmer knows how greatly depressed is the price of eggs in the summer season, simply because the supply is so much greater than the demand. But let the farmers store their eggs in such depots as this paper suggests, and a far better average price for the year must result.

The Farmer's Opportunity.

BY MR. C. B. LYMAN, SOUTHAMPTON.

There comes into the life of every one an opportunity to improve his condition by taking advantage of the conditions with which he is surrounded. With the merchant, the manufacturer, the teacher, the preacher, the speculator, the politician, with all classes of men and women, opportunities occur which if taken advantage of will make their future brighter and better, and their lives broader, more prosperous and successful. You may ask, "What is the opportunity of the farmer, or what can he do but work and dig in the same old routine of ploughing and sowing, reaping and harvesting, from early morning till late at night, with little time for reading, study or travel? Even if he could find time for these things the income from the farm is so small that he cannot afford the necessary expense." This, however, is no more true of the farmer than it is of those engaged in other trades and callings. In fact, the farmer is better off than the others in prosperity and happiness. He may not have as much money as some of the others, but what he does have furnishes him with better and purer enjoyment. You may say that his life is quiet and dull, away from the bustle and noise of the city. What if it is, he has so much more time for quiet thought and study. His mind is clearer and his conclusions are more accurate than are those of people crowded into mills and shops and other industries connected with city life.

What are some of the farmer's opportunities? One opportunity is in improving his educational advantages, for no one with a bright and active mind is so situated on a farm that he cannot be getting and storing up useful information that will be a source of happiness and usefulness all through life. He may not have the advantage of the full curriculum of the schools, but he has the advantage of observation, of

the reading of books and papers relating to his vocation, and thus by learning of the experience of others, of their successes or failures, he can go about his work in a more intelligent manner. He can study his soil, and find out by experiment the crops best adapted to the different plots he wishes to cultivate. A great deal can be learned by going to market towns and mingling with marketmen, thus gaining new ideas of the constantly increasing demand for the products of the soil and of the best time to put them upon the market.

One of the best opportunities for information is obtained by joining a good live farmers' club or grange, and faithfully attending the meetings and taking part in the discussions. In all this the farmer will keep his mind active, and receive and impart useful information. Let him visit the agricultural fairs, and observe with close attention the various exhibits of stock, machinery, seeds, grain, vegetables, fruit, the products of the dairy and kitchen and the ladies' handiwork, drawings, paintings, etc. Let him mingle with the people, and listen to their observations as the different points are discussed. He cannot help but learn something, and carry away with him valuable information which will help him in his own life on the farm. Let him visit the Agricultural College, and look over the farm and barns, and study as well as he can the growth and fertilization of the different crops, to see whether the methods in use there are adapted to his own farm or locality. In so doing he can add largely to his stock of information, and store up a good deal that will be useful and profitable for his future work.

We farmers do so much work in a hap-hazard way that a great deal of time and strength are wasted, and with little good result, thus giving us an excuse for grumbling and finding fault with all our efforts. Here is an opportunity for the farmer to put in his best work, to put into practice the knowledge he has been storing up, and thus help to put him on the right track to success.

The farmer should study his farm, to see what crops to grow that are best adapted to his locality. If near a large town or city, vegetables and small fruits such as strawberries, raspberries, currants, peaches and plums can be grown to a profit. If they are well cultivated and are properly handled

and put up in a neat and attractive manner, the vegetables in uniform bunches and the fruits alike both at the top and bottom of the basket, and you deal honestly with your customers, they will wish to buy of you every time, because they know they can depend upon you. If farther away from market, potatoes can be grown; and they are generally a profitable crop, if well cared for and put upon the market at the proper time. In many localities apple orchards may be set out, for apples will generally sell at fairly remunerative prices. In all of these operations, however, great care must be taken not to force the market, but study its wants and take advantage of its needs, and then your opportunity will be to put your produce on the market at just the right time. When you have grown your crop and it is ready for sale, if you have a good offer sell the crop, for in perhaps nine cases out of ten you will have no better offer, and frequently if not disposed of then you will have to take up with a less price.

Whatever crop you grow, do not fail to grow corn. It is one of the best crops a farmer can grow, both on account of the grain and on account of the fodder, whether fed in the form of cured stalks or as ensilage. If you have a dairy, you cannot afford to do without it. It is often remarked that we can buy such crops cheaper than we can grow them. That may be true in some few instances; but if we grow them we do not have to pay the money for them, and so far as we can we should raise what we consume. In these times of active competition it is necessary for the farmer to save all he can, in order to make both ends meet at the close of the year.

If the farm is near a city or large village, and he can keep a herd of cows, then he can engage in no more profitable business than in getting customers and furnishing them with milk and cream at retail prices; for milk at even three cents a quart is as good as butter at thirty cents a pound. If away several miles, so that he cannot make daily trips, let him put his cream in a public creamery, or, if he is a good salesman, make his own butter and take it to his customers once a week, and get a better price by selling direct to consumers.

There is one industry that has fallen off very much of

late, and it would be well for the farmers to consider whether it would not be for their profit to try and bring it back to prosperity again. I refer to the sheep industry. There are many farmers who are getting good returns from their flocks, and they are paying them as well as anything would. One of the greatest drawbacks is the damage to the flock by dogs, and this is the most discouraging feature of the business. To have gotten together a fine flock of sheep and then have them raided or spoiled by dogs is certainly enough to make the owner think of a great many expressions not found in church hymns; but there is no better maxim than to keep on trying, for it is the persevering one who succeeds.

In regard to breed of sheep for our New England farms, for very early or hot-house lambs, so called, a fine wool ewe and a Southdown buck will give the best results with the least trouble. For lambs in March, April or May, a cross between the Southdown and the Shropshire makes a good model, especially if the Southdown blood predominates. Never raise any but the best, and not in large flocks, so that they can have the best of care. A few sheep on a majority of the farms would be a profit to the owner, as well as an improvement to the farm; and if you have good lambs you will always find a market, for they are preferred by consumers to the lambs that are brought in refrigerator cars. Here is an opportunity for the farmers of our hill towns to engage in that which will be for their profit, if entered into with care and good judgment. Whatever you undertake, put in a large amount of faith and lots of hard work; be thorough in all you undertake, and do not get discouraged at a few failures, but keep at it, and it will turn out some time in your favor.

When Solon Robinson was agricultural editor of the "New York Tribune," and corn had been scarce and the price high through the winter, he wrote in the spring to the farmers of the country, asking them to plant one acre more. In the fall of that same year, in an address delivered before the Hampshire, Franklin and Hampden Agricultural Society, he said that it had been estimated that the publishing of those two lines in the "Tribune" the previous spring had increased the corn crop of the country over one million acres. But he

said: "I think I made a mistake. Instead of advising the farmers to plant one acre more, I should have urged upon them the necessity of cultivating all of their acres better." That touched the key-note of successful farming. The manufacturer, mechanic and artisan, if they expect to be successful and gain and retain the trade and confidence of their customers, know that they must make their products of the best material, and put them together in the best manner to please the eye and give the best service for which they are made. There is always a strife among them to see which shall get and retain the reputation of doing the best work and securing the largest number of customers. Here, too, lies the farmer's opportunity. Cultivate all your acres better, strive to raise a better crop of hay, corn, potatoes, vegetables, fruits or any crop that you grow on your farm. Have the best herd of cows, the best flock of sheep, the finest yoke of cattle and young growing stock, the best team of horses. Raise all of your own stock, if possible, gain a reputation for having the best, and your stock will always be in demand and will bring you remunerative prices, and your success will stimulate others to make an effort to do better than you have done.

If this were done, not many years would elapse before a great change would come over the farming community. The farms would be better cultivated, the fences would be in better order, the waysides would be cleaner, the brush and stones would be cleared out of mowing and pasture where practicable and where not practicable the land left to grow up to forest.

Lay out no more work than you can do thoroughly. Keep your buildings in good repair. It is not necessary for comfort and attractive appearance to have an imposing mansion, you may not be able to afford that, but what you do have take care of. Have no loose boards hanging by one nail and threatening to fall in every high wind, and leave an ugly looking gap that has the appearance of shiftlessness. Promptly make repairs, for one nail now may save nine later. Keep the lawn about the house neat and free from rubbish that would mar its beauty. Plant a tree here, a shrub there, a rose bush in this corner, a flowering plant

in the other corner; lay out a plot for flowers of the best varieties that will give you blossoms through the season. Have a garden sufficient to raise your own vegetables and some to spare for your less fortunate neighbors, and small fruits and berries to give you plenty of luscious fruit throughout the season. Have a pride in your surroundings, so that passers-by will take note of them and will remark, "I always like to go by this place, because everything is kept in such good repair, and so much pains is taken to have it look neat and attractive."

But all comfort must not be on the outside. The inside must be neat, attractive and fitted up for comfort. It is not necessary to have frescoed walls or upholstered furniture or Brussels carpets. Wall paper and paint are cheap, and are easily put on. A few pictures should be on the walls, books in the book-case, papers and magazines on the table, a few ornaments on the shelves, a lounge or two and a few comfortable chairs, so that when you come in from the work of the farm or other duties you will have and take more solid comfort than if you owned the greatest mansion in the land.

Farmers should take the opportunity to co-operate together and thus help one another, to look out for each other's interests, and be ready to lend a helping hand in trouble. If you know of a good thing for yourself, let others know how it can be a help to them. Not every farmer is calculated for a good salesman, so let the farmers of a town combine and form themselves into a co-operative society for their mutual benefit. In the purchase of supplies and in the sale of their products let them select one of their number to act as their agent. Let him keep himself posted on the condition of the market, and learn when is the best time to buy or to make a sale of farm products. Let the farmers, when they have produce to sell, send notice to the agent to that effect, and have him advertise the same. Or, when they wish to buy stock or supplies needed on the farm, have him make their wants known by keeping a record of "wants" and "for sale," so that parties can go to him, and he, by turning to the record book, can give the required information then and there and with little trouble. It is a well-known fact that buyers of produce will go where a large quantity of what

they want can be found together, and such parties will get better prices than will the owners of small lots scattered over a large area. Now, through this agent the buyer can find what he wants, and time and trouble can be saved both the seller and buyer, and both be benefited. If this plan were carried out a better feeling and closer relation would exist between farmers, and it would help to make their lives pleasanter and happier and more profitable than would have been possible without this co-operative action.

Another opportunity which the farmer should improve is to take an active part in political affairs, and do what he can to influence legislation in the right direction. He should see that the burden of taxation does not fall upon the farmers more heavily than upon those engaged in other callings. Every farmer is willing to pay his part, but it ought not to be asked of him to do more. Farmers can do a great deal to improve their conditions along these lines. They can see to it that those of their own profession are elected to represent them in the halls of legislation. One reason why this is not done as much as it ought to be is because there is too much jealousy among farmers, and they are afraid that one of their number will get honored more than themselves. So, rather than have him promoted to where he can do good and effective work, we throw him aside and give our influence to the election of a professional man, who does not take any particular interest in our necessities. Thus many a measure that would be a benefit to the farmer is lost, and we grumble because there are so few farmers elected to legislative offices. This ought not so to be, for there are no citizens more intelligent or better able to express their views than are those of the farming community. It is said of clergymen who preach in cities that when they go into the country to preach they take their best sermons with them, because the country congregations are more critical than are those of the city.

The farmers should exert their influence against the idea of paternalism, or a few dictating how the many shall be governed. Take, for instance, our district schools, which the Board of Education is trying to centralize by taking the scholars from the outlying districts and transporting them to one graded school in the centre. In some respects this might

be better for a few, but for the many a positive injury. If the people are few in number, keep up all your schools, for it is for the benefit of the whole community, the salvation of all parts of the town, and will act as a check on the supply of abandoned farms. To transport children from five to ten years of age, three, four, five and in some instances six miles, is an outrage, and a vigorous protest against it should go up in every farming community. The farmer should take a great interest in the schools of his own town. Make them as good as means and circumstances will allow. Encourage the scholars to be faithful and punctual in attendance. Give them good teachers and encourage them in every possible way. See to it that the dullest scholar has his share of attention, for, if well looked after, he may turn out to be the brightest in the end. Remember that the prosperity of your town is centred in the prosperity of the district schools.

The farming class should see to it that the churches are well sustained. If you have two churches, and population for only one, unite, even though you differ somewhat in your creed. Do not let that hinder the union, for one well-sustained church is better than two or three struggling for an existence. It is for your temporal interest that there should be at least one church in your community. I well remember, many years ago, being in the office of a then prominent man in one of the hill towns in the western part of the State. We were speaking about the church and the efforts being made to raise money to pay the preacher's salary for the year, and of his advice to different persons to give a certain sum to maintain this service. "Why," he said, "not that I care a —— about religion; but what will our farms be worth, without any preaching or Sunday service?" And so I say to you farmers: What will our farms be worth, unless we have the public schools and the church sustained in our own town or community?

Another thing that should call forth the earnest protest of the farmers is the effort now being made to take away from them the control of the State Board of Agriculture, and place it under the control of a few, to be appointed by the governor, these few to tell the farmer what he needs, on the supposition that they, no matter of what profession, are better

able to do this than are the farmers themselves. Now, the farmers are not such ignoramuses as these people would have us believe. Let us hope that these efforts to put themselves in the front and the farmers in the rear will not prevail.

The farmer has the best opportunity to look on the bright side of things. He is never troubled for want of work, for on a farm there is never a lack for something to do, no necessity for standing around idle. The crops are always working in their season. If the farmer takes a holiday now and then, judiciously selecting the time, nature will keep at work, the crops continue to grow, the cattle to feed, and the income will not stop. What if sometimes some crops seem to have failed; they have not all failed. There are yet bright spots, if we will but look for them; some silver lining to every cloud, and if we will but look up, it will show itself to our vision.

It is Whittier, I think, who says in one of his poems: —

"Once more the liberal year laughs out,
O'er richer stores than gems of gold;
Once more with harvest song and shout,
Is Nature's bloodless triumph told.

"Our common mother sits and sings,
Like Ruth among her garnished sheaves;
Her lap is full of goodly things,
Her brow is bright with autumn leaves.

"O favors every year made new,
O gifts with rain and sunshine sent;
The bounty overruns our due,
The fulness shames our discontent.

"We shut our eyes, the flowers bloom on;
We murmur, but the corn ears fill;
We seek the shadow, but the sun
That cast it shines behind us still."

The farmer should look on the bright side of life. He should not be discouraged at a partial failure now and then, for it may be brighter the next year. The return may be slow, but it will be sure to come some time. Do not be in a hurry to change your business or your location. A well-kept home diminishes a desire for a change, for we are apt to love that upon which we bestowed much care, and are

loth to separate from it; and, wherever we may go and what other scenes of beauty we may look upon, we are always glad to get back to our own home. And our children, as they grow up to manhood and womanhood, will be loth to leave the old home; but wherever they go, — for some of them must go, — they will look back to it as the one bright spot they love best on earth.

Let us make all the friends we can. Let us invest in all the pleasures that will lift us up higher and make us happier and more satisfied with our surroundings. You are probably familiar with the story of the vessel that was disabled by a storm at sea, dismantled and driven hither and thither with the winds and the waves, the crew exhausted and out of water, and looking and waiting anxiously for some passing vessel to come that way and give them relief. At length, when they had almost given up in despair, they discovered a ship coming towards them under full sail. They watched it coming nearer and nearer, and when it was within speaking distance the captain shouted, with all the strength he in his exhausted condition could command, "Water, water! Give us water, — we are dying of thirst!" Back over the waves came the answering cry, "Dip it up! dip it up! You are in the mouth of the Amazon." So I say to you discouraged farmers who are looking and waiting for some one to come along and buy your farm and home, and thus relieve your present distress, even at a great sacrifice, so that you can try your luck in some other place or in some other business, Dip it up! Dip it up! There are yet capabilities in the soil you now possess, that lies at your very feet, that you have never dreamed of. There is still a chance to redeem the time, a chance to make a great change for the better. Go to work with an energy and faith that will admit of no failure, and you will overcome the obstacles that lie in your pathway, and with Heaven's blessing you will succeed.

BULLETINS

MASSACHUSETTS BOARD OF AGRICULTURE,

PUBLISHED IN

MASSACHUSETTS CROP REPORTS, 1896.

The Grass Crop.

BY DR. C. A. GOESSMANN, CHEMIST TO THE BOARD.

Within a few pages I propose to discuss briefly some of the points which deserve a serious consideration when aiming at a remunerative production of grasses for fodder. A short description of some field experiments with grasses carried on by the writer during a series of years upon the fields of the Massachusetts Agricultural College may serve in some measure as an illustration in the matter.

Adaptation of Soil.

A successful production of our valuable meadow and pasture grasses depends in a less degree on any particular kind of soil than on a well-regulated, constant supply of moisture. Light, sandy soils are known to furnish good meadows and pastures, provided the necessary amount of moisture and of suitable available plant food is furnished during the entire growing season. A deep loam or mellow clayish loam is, however, considered the typical soil for grass lands. Our best meadows are found as a rule upon lands which contain either a liberal admixture of a fine clayish silt in their original make-up or receive periodical addition of that kind by overflow or otherwise. These materials are usually comparatively rich in various kinds of plant food; they exert in many instances a beneficial effect on the retentive qualities of the soil, as far as moisture and available plant food are concerned; and they tend to protect the root system against extremes of climate and season, by rendering the soil more compact and closed up.

No class of crops is more seriously affected by a periodical access of an excess of water or by exposure to a serious period of dryness than the grasses. A frequent occurrence of

these conditions, even for a comparatively short period, during the growing season causes gradually serious changes in the whole character of the growth upon grass lands. A wet condition of the soil due to a high local level of the water in the soil favors the appearance of an inferior class of grasses; stagnant water is destructive to all good grasses; while a continued dryness of the soil favors the appearance of a class of herbaceous plants characteristic to dry pastures. The stated results become in the same degree more marked as these undesirable conditions occur or continue.

Well-devised systems of underdraining or of irrigation are efficient remedies wherever local circumstances admit of an unrestricted judicious management. The growth upon wet lands not capable of underdraining is not unfrequently materially improved by ditching or by raising the surface of the land with a layer of a light, sandy soil several inches in thickness above the previous level of the ground water. A choice of either one or the other of these modes of improvement or a combination of both depend for obvious reasons on local resources, to accomplish the end in view at a reasonable outlay.

Dry lands unfavorably located for irrigation, or under the influence of adverse climatic conditions, as frequent scarcity of rain during the growing season, offer but little inducement for the cultivation of perennial grasses. The bad effect of short spells of dryness may be somewhat modified by adding the seeds of some valuable broad-leaved fodder plant, for instance, medium red clover or white clover, for the purpose of shading the ground and thereby economizing existing local resources of moisture. Some of our better grasses are less affected by spells of dry weather than others; a due consideration of this fact in selecting among these for cultivation tends to materially improve the chances of success. Meadows and pastures which are in an exceptional degree inclined to a spontaneous growth of an inferior class of fodder plants and weeds, if at all fit for a more thorough system of cultivation, ought to be ploughed up and subsequently for some years planted with some hoed crop or subjected to drill culture, for the purpose of destroying effectually the foul growth and improving the physical and chemical condition of the

soil. These lands prove in many instances more profitable when planted with other fodder crops than grasses.

Manuring Grass Lands.

Next in importance to a fair degree of special adaptation of the soil for a remunerative production of grasses come the requirements of an efficient supply of available plant food. Grasses are, comparatively speaking, large consumers of plant food. A few numerical statements regarding the grass crop may show in what direction and in what varying quantities the same weight of the crop may consume the different articles of plant food when raised under more or less favorable conditions.

Green grass, at the time of forming seeds, contains seventy-five per cent moisture and twenty-five per cent vegetable matter per ton : —

Moisture, ...	1,500.00 pounds.		
Vegetable matter, ...	500.00 pounds.		
Mineral constituents (in vegetable matter), ...	36.00 to 44.00 pounds.		
Nitrogen, ...	8.00 to 14.00	"	(12 cents).
Phosphoric acid, ...	2.40 to 4.40	"	(4.5 cents).
Potassium oxide, ...	9.00 to 16.00	"	(4.5 cents).
Calcium oxide, ...	2.00 to 5.60	"	
Magnesium oxide, ...	.80 to 2.40	"	
Sodium oxide, ...	.60 to 1.60	"	
Sulphuric acid, ...	1.60 to 2.00	"	
Chlorine, ...	2.20 to 4.20	"	
Manurial value, ...			$1.38 to $2.58

Meadow hay (per ton), containing from fourteen to fifteen per cent of moisture : —

Moisture, ...	280.00 to	300.00	pounds.
Vegetable matter, ...	1,700.00 to	1,720.00	"
Mineral constituents (in vegetable matter),	100.00 to	160.00	"
Nitrogen, ...	30.00 to	50.00	"
Phosphoric acid, ...	7.00 to	14.00	"
Potassium oxide, ...	32.00 to	64.00	"
Calcium oxide, ...	6.00 to	20.00	"
Magnesium oxide, ...	3.00 to	10.00	"
Sodium oxide, ...	2.60 to	6.00	"
Sulphuric acid, ...	5.50 to	9.00	"
Chlorine, ...	7.50 to	16.00	"
Manurial value, ...		$5.36 to $10.50	

Experience tells us that a liberal manuring pays better than a scant one; yet, if we should try to restore to the soil from outside sources a corresponding amount of all the fertilizing constituents which the grass crop abstracts, it would make, in most instances, the remunerative production of the hay crop rather an exception than the rule.

Good economy advises us to manure our lands with a particular reference to special wants. To do this intelligently requires a fair knowledge regarding the following points: —

1. The general character of the soil, the location of the lands, the history of their former treatment as far as the system of manuring is concerned, as well as the kinds of crops which have been previously raised upon them.

2. The quality and relative quantity of the various essential articles of plant food which a satisfactory yield of the contemplated crop requires.

3. The degree of natural fitness of the plant to be raised to avail itself not only of the atmospheric plant food, but also of the existing inherent amount of plant food in the soil to be used for its production. The development of their root and leaf system, as well as the shorter or longer period of time required for their growth, deserves a most serious consideration in this connection.

Perennial plants are as a rule better qualified to benefit by existing and inherent resources of plant food of the air and the soil. Our best meadow grasses are perennials. Their long period of growth, supported by a liberal development of leaves and roots, enables them to benefit in an exceptionally high degree by the inherent resources of plant food of the soil engaged in their production and of the atmosphere. They are for this reason less exacting, as far as an additional supply of plant food is concerned; and they can be raised upon a naturally good soil, fit for grass production, at a less expense for manure than the majority of general farm crops. This fact, however, ought not to lead to the belief that manuring grass lands is not profitable in the majority of cases; for permanent grass lands, meadows and pastures which produce to-day remunerative crops without the assistance of manurial matter of some kind or other from outside sources are rather the exception than the rule. The unsatisfactory

condition reported of the majority of our grass lands has to be largely ascribed to the prevalence of an indifferent system of manuring them.

The cultivation of one and the same crop or class of crops year after year upon the same lands without some rational mode of manuring cannot fail to change gradually but surely the mechanical as well as chemical character of the soil for the better or the worse, as far as that crop or class of crops is concerned, — in the majority of cases for the worse.

A reliable general fertilizer for grass lands has to be compounded on the same rules which are recognized as rational with reference to other farm crops; *i.e.*, it ought to provide for the return of those essential articles of plant food which the grass crop in an exceptional degree has removed from the soil upon which it has been raised. It is to be remembered that wherever the grass crop is still the main source of coarse fodder for farm live stock the product of the fertility of grass lands is constantly turned to account for the improvement of the lands used for the cultivation of other farm crops. This once universal practice of manuring farm lands has ceased to be advisable or even excusable, since a well-developed trade in commercial fertilizers provides amply the needed remedy, — more manure. Its ruinous influence on the original productiveness of the farm lands in all civilized countries, ours not excepted, wherever important farm products, as grains, etc., have been largely sent to market without any return of the plant food they contained, is fully recognized.

The grass crop contains on an average one part of phosphoric acid to four of potash and three of nitrogen. In case of newly laid down grass lands it is well to adhere to that proportion. In case of old grass lands with an abundance of vegetable decayed matter the amount of nitrogen may be safely reduced one-half. It is not possible to state more definitely the exact amount of nitrogen, phosphoric acid and potash which will secure the best results, on account of the widely varying condition of grass lands as far as their state of fertility is concerned. Taking two tons of hay as an average yield per acre as the basis, from twenty to twenty-five pounds of available phosphoric acid, one hundred pounds of available potassium oxide, with thirty pounds of available

nitrogen per acre, would fairly meet the average condition. This fertilizer can be secured to-day at about from eight to nine dollars in the best form for immediate action. It is not advisable to reduce the nitrogen in our grass manures to too small quantities, for the best grass crops contain the largest amount of valuable nitrogen compounds.

No single article of plant food acts independently of the rest; a liberal amount of nitrogen assists in the liberal assimilation of phosphoric acid and potash: these elements have a close relation to each other in many of our fodder crops. A fair state of fertility of the soil is an indispensable requirement for a successful production and propagation of our most valuable grasses.

Quite frequently the entire character of the growth upon grass lands has been improved by changing from a scant to a liberal manuring, without any assistance from new seeds. Those grasses which are best adapted to the altered conditions of the soil take the lead.

The nutritive value of one and the same species or variety of grasses is liable to differ in a more serious degree, when raised under more or less advantageous circumstances, than many of our reputed meadow grasses are represented to differ among themselves, when raised under conditions which favor their successful growth.

Forage crops, above all other crops, suffer more seriously in regard to quality from a scant supply of plant food than any other class of farm crops. Large areas of grass lands are still too frequently treated with all kinds of manurial substances, without any definite idea of what they can or shall accomplish. A short discussion of some of the more prominently mentioned substances frequently used for manurial purposes upon permanent grass lands may illustrate that statement.

Common salt is known quite frequently to act beneficially on grass lands; it acts, however, more decidedly on the physical qualities of the soil than as a direct plant feeder; it assists in the absorption of moisture from the air and economizes inherent resources of moisture, and is thus apt to act better on dry lands than on moist ones; it assists in the diffusion of potash and phosphoric acid, but does not materially

benefit the supply of the most essential article of plant food. The beneficial effect usually ceases after a few applications of from four hundred to five hundred pounds per acre; the lands are more exhausted after its exclusive use as a manure than before.

Gypsum, or plaster, aids in the absorption of the ammonia compounds of the air; it counteracts the tendency of a clayish soil to become hard and impervious in dry weather; it assists, like salt, in the general diffusion of potash and phosphoric acid present, by causing favorable transformations of existing compounds. A few repeated applications of from six hundred to seven hundred pounds per acre usually terminate its good services, which are frequently marked rather by a more liberal growth of clover and of leguminous plants in general than by that of grasses. Aside from lime and sulphuric acid, nothing is added to the future fitness of the soil, as far as essential articles of plant food are concerned. Gypsum, as a *sole* manurial matter used on grass lands, assists in bringing nearer the time of their failure as a remunerative fodder source.

Air-slacked lime, lime-kiln ashes and various other kinds of lime refuse are noted for their good influence on grass lands; they assist in producing a favorable decomposition of organic matter by neutralizing accumulated organic acids and securing thereby conditions favorable to the action of a beneficial microbic life in the soil. They aid in the disintegration of potash containing silicious soil constituents, and render thereby inherent sources of plant food more available; they improve the general physical conditions of a compact, clayish soil by rendering it more mellow and permeable. As a direct addition of plant food they are only in exceptional cases of real importance; they are in the majority of cases worthless upon a calcareous soil.

Marls and clayish marls, free from any perceptible amount of potash and phosphoric acid, act in the main similarly to the previously mentioned lime refuse. Earthy composts of various descriptions, if applied in large quantities, frequently act very beneficially on exposed portions of the upper part of grass roots by protecting them against an undesirable exposure to light and atmosphere, thereby favoring the forma-

tion of new and more numerous shoots. They benefit the inherent stock of plant food only as much as they contain one or more of them in an available condition, which is usually an unknown quantity.

Other substances, quite frequently of a mere local interest, might be added to the previous list, if space permitted.

Most of these previously stated manurial substances, it will be noticed, are only temporary remedies, if any. They assist more or less in economizing existing local resources of plant food. They may, however, if used intelligently, quite frequently serve as valuable helpmates in a more rational and more comprehensive economical system of manuring grass lands capable of a remunerative improvement. As an economical source of phosphoric acid, aside from ground bone, which furnishes phosphoric acid and nitrogen, in many instances finely ground mineral phosphate from Florida, South Carolina, West Indies and other localities deserves recommendation for grass lands as a top-dressing, on account of low cost. Kainite and muriate of potash are to-day our most efficient and cheapest sources of potash for forage crops.

Wood ashes are a valuable fertilizer for grass lands, if applied in sufficient quantities; our average unleached Canada wood ash contains from 5 to 6 per cent of potassium oxide, 1.5 to 2.5 per cent of phosphoric acid and 30 to 35 per cent of calcium oxide (lime), besides small quantities of every other essential mineral constituent required for a successful growth of plants. The absence of nitrogen is somewhat compensated for by the presence of a liberal amount of lime, which favors a rapid decomposition of the vegetable matter contained in the soil. The nitrogen of the vegetable refuse matter becomes thereby in a high degree available. The good effect of wood ashes is for this reason more striking upon grass lands, rich in vegetable refuse matter, than upon dry lands, which as a rule contain less of the latter.

The good services of barn-yard manure for the production of grasses are generally recognized, yet its efficiency may be greatly increased in this connection by the addition of some suitable potash compound, to turn its excess of nitrogen to

better account. Two thousand pounds of barn-yard manure contain on an average eight to ten pounds of nitrogen, four to five pounds of phosphoric acid and nine to twelve pounds of potassium oxide. Fifty pounds of muriate of potash to every ton of barn-yard manure needed will serve a good purpose, and in many cases allow a reduction in the amount of barn-yard manure otherwise considered necessary. A top-dressing of grass land with two hundred pounds of muriate of potash and five hundred pounds of fine-ground bone has given much satisfaction in our field experiments. Our grass lands are as a rule deficient in available potash compounds.

On Selection of Seed.

The family of grasses is very numerous, — it includes all our cereals; the number of those cultivated by human effort is, however, comparatively small for limited districts. The majority of grasses are of a spontaneous growth, and in their general character, in a controlling degree, depend on the condition of the soil and climate. In regard to their duration of life they may be classified into annual, biennial and perennial grasses. The annual and biennial grasses are propagated by seeds and the perennials usually by both seeds and sprouts starting from the roots.

In examining the different grasses with reference to their mode of growth we notice a more or less marked difference among different species and varieties. Some show a decided tendency to soon send out numerous upright shoots, bearing liberally flowers; while others show this tendency more sparingly, and spend their vital energy in the production of numerous low, knotty shoots, clinging more or less closely to the ground, thereby forming a close sod. This class of grasses requires frequently from two to three years after seeding before it contributes liberally to the hay crop; it furnishes meanwhile valuable pastures.

To secure upon temporary grass lands a good and early annual yield of hay, it is necessary to select largely the seeds of those grasses which send out at once many tall, blooming shoots. The shorter the period designed for keeping the lands covered with grasses, the more ought low-growing perennial grasses to be excluded.

The degree of success upon permanent meadows, as far as the quality and quantity of the annual yield of hay is concerned, depends largely upon the care taken to ascertain the most advantageous relative proportion of both mentioned classes of grasses under existing local circumstances. To secure the highest attainable yield requires careful local observations.

Grasses raised upon one and the same land should also be selected as far as practicable with reference to a *corresponding period of blooming;* they should be cut for hay when the majority of them are fairly advanced in blooming. The adoption of this course imparts to the crop the highest attainable nutritive value. The following statement contains the names of some of the prominent grasses, classified with reference to their tendency of growth and their adaptation to dry and moist soils: —

List of Reputed Grasses (Perennials).

I. For Dry or Moderately Moist Soils.

(*a*) First class (tall-growing grasses): —	
Meadow fox-tail (*Alopecurus pratensis*),	May to June.
Meadow fescue (*Festuca pratensis*),	June to July.
Red fescue (*Festuca rubra*),	June to July.
Timothy, herd's grass (*Phleum pratense*),	June to July.
(*b*) Second class (low-growing grasses): —	
English bent (*Agrostis alba*),	June to July.
Sweet-scented vernal grass (*Anthoxanthum odoratum*),	May to June.
Yellow oat grass (*Avena flavescens*),	May to June.
Sheep's fescue (*Festuca ovina*),	June to July.
Downy oat grass (*Avena pubescens*),	July.
French rye grass, tall oat grass (*Arrhenatherum avenaceum*),	May to July.
English rye grass (*Lolium perenne*),	June.
Italian rye grass (*Lolium italicum*),	June.
Kentucky blue-grass (*Poa pratensis*),	May to June.

II. For Moist and Wet Soils.

(*a*) First class (tall-growing grasses): —	
Timothy, herd's grass (*Phleum pratense*),	June to July.
Fowl meadow (*Poa serotina*),	July to August.
Rough-stalked meadow grass (*Poa trivialis*),	June.
Meadow soft grass (*Holcus lanatus*),	June to August.
Orchard grass (*Dactylis glomerata*),	May to June.

Soft brome grass (*Bromus mollis*), ...	June.
Italian rye grass (*Lolium italicum*), ...	June
(*b*) Second class (low-growing grasses) : —	
Red top, Rhode Island bent (*Agrostis vulgaris*), . .	July.
English rye grass (*Lolium perenne*), ...	June.
Crested dog-tail (*Cynosarus cristatus*)	June to July.
Common manna grass (*Glyceria fluitans*), . . .	June to July.

The degree of success upon permanent meadows, as far as the quality and the quantity of the annual yield are concerned, depends largely on the care taken to ascertain the most advantageous relative proportion of both mentioned classes of grasses under existing local circumstances. To secure the highest attainable yield requires careful local observations. Receipts for mixtures of grass seeds which have proved advantageous in one locality cannot always be relied on as best in any other place. For this reason, instead of discussing the merits of any of the many mixtures recommended by seed dealers and others, I refer to the mixture used in my own case at Amherst, which is stated on a subsequent page.

Course adopted in reclaiming an Old Meadow.

The area engaged in the experiment amounted to from nine to ten acres, running from south to north along the western slope of a natural grove. The main part of the land is fairly on a level, slanting slightly towards the north and rising somewhat from the centre of the field towards the grove; this part is somewhat springy. The southern end of the land is exposed to an occasional overflow of water from adjoining hillsides. The outlet for the water, coming from both sources, had evidently been gradually obstructed by soil washed down from elevations along the north end of the field. As a natural consequence, a large part of the ground had been changed into an unsightly swamp. The entire area was covered with a worthless growth peculiar to exhausted dry lands and wet meadows, the latter in particular. The surface soil consisted of a sandy loam, from two to three feet in thickness, which was here and there underlaid by either a thin layer of hardened clay or a coarse, gravelly material. The general character of the surface

soil, as well as the apparent chances of regulating its state of moisture, promised to make the field, under proper management, in an exceptional degree fit for a permanent meadow.

After lowering the outlet for the water through the adjoining lands at the northern termination of the field, it was decided to run, from ten to twelve feet apart, two parallel ditches from north to south, through the lowest part of the land. The ditching began in the month of August. One ditch from three and one-half to four feet below the surface of the ground was to serve as a main ditch for drain tiles six inches in diameter, to prevent an accumulation and subsequent stagnation of water in the upper soil. The other was an open ditch, on an average from one foot to eighteen inches deep, to assist in a speedy discharge of surface water, due to heavy rains or the melting of the snow and ice on adjoining hillsides in the spring. In both instances the necessary fall was secured to dispose of the surplus water. One surface ditch sufficed for the whole area, while branch tile drains were built to all places where local conditions indicated an exceptional state of moisture. The tiles in the branch ditches varied from two to four inches in diameter. A stone drain ten by twenty feet wide and four feet deep served as a filter for the turbid water coming from the adjoining hillsides in case of heavy rains, before entering the tile drains. The surface ditch ran up to the stone drain, to prevent a general overflow of the meadow in case of exceptional rainfalls, etc. The deep, swampy places were filled up in part with stones and earth, or earth, as circumstances advised. The entire area was subsequently ploughed deep and left in that state over winter. The succeeding spring a wheel harrow was used to break up the rotten sod. The soil was subsequently ploughed and harrowed repeatedly, until it showed the desirable mechanical condition required for a successful cultivation of summer grain crops.

Barley and oats were chosen as the first crops. Both were seeded in drills, with rows two feet apart, to permit a thorough destruction of an objectionable foul growth by frequent use of the cultivator and hoe.

As soon as these crops were harvested, one ton of wood ashes per acre was ploughed in, to assist in the disintegration

of the excess of organic peaty matter, and to serve as a general fertilizer. After ploughing and smoothing the surface by means of a brush harrow, the entire area was seeded down, in September, into grass, to serve as a permanent meadow. The more elevated portions of the field were seeded down with the following mixture of grass seeds, at the rate of from two to two and one-half bushels per acre: —

Two bushels herd's grass (*Phleum pratense*).
Two bushels red top (*Agrostis vulgaris*).
Two bushels Kentucky blue-grass (*Poa pratensis*).
Two bushels meadow fescue (*Festuca pratensis*).
Five pounds sweet-scented vernal grass (*Anthoxanthum odoratum*).

The lower and still more wet portion of the meadow was seeded down with the following mixture of grass seeds: —

Twenty pounds of soft brome grass (*Bromus mollis*).
Twelve pounds herd's grass (*Phleum pratense*).
Nine pounds red fescue (*Festuca rubra*).
Eight pounds fowl meadow grass (*Poa serotina*).
Seven pounds Rhode Island bent (*Agrostis vulgaris*).
Six pounds orchard grass (*Dactylis glomerata*).
Five pounds crested dog-tail (*Cynosurus cristatus*).
Four pounds meadow soft grass (*Holcus lanatus*).
Two pounds sweet-scented vernal grass (*Anthoxanthum odoratum*).

From four to five pounds of alsike clover per acre were added by broadcast seeding early in the succeeding spring (1889). The seed came up well, and suffered but here and there in wet spots during the first winter. Barren spots were reseeded. The entire meadow was cut but once during the first summer season, somewhat later than usual; the majority of grasses did not, as might be expected, head out.

As soon as the first crop of hay was secured, a system of manuring was planned, to show the comparative manurial effect of top-dressing, as follows: by barn-yard manure; by ground bone and muriate of potash; by unleached wood ashes. From 1889 to 1893 the quantity of barn-yard manure was gradually reduced, to ascertain how far different quantities used per acre would affect the final results. Since 1893 each plat has received in succession annually the same quantity of one of the different kinds of manure, *to try a rotation of manures upon permanent grass lands*. The annual yield of hay on the different plats is stated below: —

Summary of Yield of Hay (Tons).

	Rate per Acre (Tons).		
	First Cut.	Second Cut.	Total.
1889.			
Plat 1, barn-yard manure, eighteen tons to acre,	2.73	1.14	3.87
Plat 2, barn-yard manure, eight tons to acre,	2.38	1.21	3.59
Plat 3, six hundred pounds steamed bone and two hundred pounds muriate of potash to acre,	2.50	1.03	3.53
1890.			
Plat 1, barn-yard manure, fourteen tons to acre,	3.80	1.00	4.80
Plat 2, barn-yard manure, eleven tons to acre,	3.25	1.34	4.59
Plat 3, as in 1889 (six hundred pounds steamed bone and two hundred pounds muriate of potash to acre),	3.00	.73	3.73
Plat 4, wood ashes, one ton to acre,	2.23	.68	2.91
1891.			
Plat 1, barn-yard manure, eight tons to acre,	3.26	.72	3.98
Plat 2, barn-yard manure, six tons to acre,	2.99	.72	3.71
Plat 3, as in 1890 (six hundred pounds steamed bone and two hundred pounds muriate of potash to acre),	2.32	.51	2.83
Plat 4, as in 1890 (wood ashes, one ton to acre),	2.32	.51	2.83
1892.			
Plat 1, fertilized the same as in 1891,	2.77	1.04	3.81
Plat 2, fertilized the same as in 1891,	2.70	.98	3.68
Plat 3, fertilized the same as in 1891,	2.33	.64	2.97
Plat 4, fertilized the same as in 1891,	2.18	1.02	3.20
1893.			
Plat 1, wood ashes, one ton to acre,	2.28	.77	3.05
Plat 2, barn-yard manure, eight tons to acre,	2.62	.86	3.48
Plat 3, six hundred pounds ground bone and two hundred pounds muriate of potash to acre,	1.94	.64	2.58
1894.			
Plat 1, wood ashes, one ton to acre,	2.50	.37	2.87
Plat 2, barn-yard manure, eight tons to acre,	2.86	.51	3.37
Plat 3, six hundred pounds ground bone and two hundred pounds muriate of potash to acre,	2.54	.18	2.72
1895.			
Plat 1, six hundred pounds ground bone and two hundred pounds muriate of potash to acre,	2.18	1.60	3.14
Plat 2, wood ashes one ton to acre,	2.17	1.44	3.12
Plat 3, barn-yard manure, eight tons to acre,	3.02	1.04	3.13

The season of 1894 was marked by a severe drought, beginning with the month of July and extending into the fall, which affected the yield of the crop (second cut) to a serious extent. The season of 1895 was a fair one for farm work in our section of the country.

The rotation of manures upon permanent grass lands deserves a recommendation.

The Army Worm.

(*Leucania unipuncta*, Haw.)

BY A. H. KIRKLAND, M.S., ASSISTANT ENTOMOLOGIST TO THE COMMITTEE ON THE GYPSY MOTH, INSECTS AND BIRDS.

It would seem a matter of simple justice on the part of nature to eliminate from time to time the old and long-fought insect pests of the farmer as new and more dangerous ones appear, but that no such good fortune is in store for the agriculturist is shown by the reappearance this year of the army worm, accompanied by wide-spread damage throughout the State. The farmer and fruit grower may justly contemplate with anxiety such comparatively recent insect importations as the gypsy moth and San José scale, but when, in addition, it becomes necessary to combat serious devastations of the old-time insect pests, the romance and profits of agricultural pursuits are materially lessened, and particular emphasis attaches to the thought that eternal vigilance is the price of good crops. While by the time this paper reaches its readers the danger from the army worm will probably have passed, the possibility of outbreaks next year in those sections of the State where this pest has done but little damage this season indicates the necessity of disseminating information concerning the habits of the insect and the means of checking its devastations.

Life History.

The life history of the army worm is in brief as follows: the eggs (Fig. 1), of a glistening white color, are laid by the parent moth in rows of about twenty eggs each in the sheaths of grasses and grains, and on stubble, stacks of straw, etc. Often several rows of eggs are deposited on a single plant, and each female moth lays about five hundred eggs.

Upon hatching, these eggs give rise to small, dark, smooth-skinned caterpillars (true cut worms), which feed greedily upon grasses and grains. The full-grown caterpillar (Fig. 2) is about one and one-half inches in length, and has a dark dorsal stripe extending the whole length of the body. Following this stripe on each side of the body there are three narrow, fairly well-defined stripes, the first being grayish yellow, the second dark brown, and the third, extending along the body just above the legs, of a rust-yellow color. The under surface is light brown. All the body colors are subject to much variation. In this stage the insect has the habit, common to other cut worms, of curling itself up when disturbed.

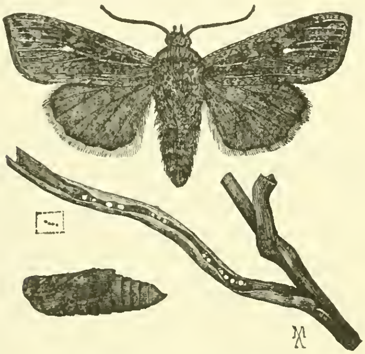

FIG. 1.— ARMY WORM.

Moth, eggs and pupa. (From Department of Agriculture Report, 1879.)

FIG. 2.—ARMY WORM.

Caterpillar. (From Department of Agriculture Report, 1879.)

When full grown the caterpillars bury themselves in the soil to a depth of two or three inches, and there transform into dark-brown pupæ (Fig. 1), which, in the course of two or three weeks, give rise to winged moths. These moths (Fig. 1) are of a reddish-brown color, expand about one and one-half inches and have near the centre of the fore wings a small white spot. The middle of each hind wing bears on the under surface a small black spot.

The natural breeding place of the army worm is said to be on the borders of swamps, where the grasses common to such places furnish suitable food for the insect, and from such localities in favorable years large numbers emerge to bring devastation upon surrounding fields.

There has been considerable controversy among entomologists concerning the number of annual broods of this insect. In the southern sections of the United States there are, according to Prof. L. O. Howard,* possibly as many as six annual broods, while in New England there are undoubtedly two broods yearly. This last statement may not hold true for the cranberry region of Cape Cod, where the army worm frequently causes much damage. From studies made on the Cape during 1894 Mr. C. P. Lounsbury † came to the conclusion that the insect was there probably single-brooded.

The question of the stage in which the army worm passes the winter has an important bearing upon the number of annual broods. It is generally conceded that in this region the insects pass the winter as partially grown caterpillars (from the fall, or second, brood), which attain their full growth the following spring, transform and give rise to moths which lay their eggs in grass and grain.

These views concerning the number of annual broods and the question of hibernation find additional support in a peculiar feature of the outbreak of this season. Many of the fields worst damaged by the insect were those sown in the spring of this year. I found during the first week in July innumerable small larvæ not over one-third to one-half an inch in length scattered throughout these spring grain fields. and at a greater distance from grass lands than these diminutive insects could possibly have travelled. Clearly then the eggs from which these insects came must have been laid in the grain fields by moths emerging from the hibernating brood of the previous season.

* Circular No. 4, 2d series, U. S. Dept. Agr., Div. of Entomology, 1894.

† Bulletin 28, Hatch Experiment Station, 1895.

FIG. 3.

Food Plants.

The army worm is a general feeder upon grasses and grains, but when pressed by hunger will attack many garden vegetables and other herbage. It has this year been noticed feeding upon cranberry, oats, rye, barley, corn, herd's grass, orchard grass, red top, witch grass, peas, beans, beets, lettuce, cabbage, pig weed, yellow dock and purslane. Mr. C. A. Peters, a student of the Massachusetts Agricultural College, informs me that it also attacks barn-yard grass (*Panicum crus-galli*), shepherd's-purse and vetches. Figs. 3, 4 and 5 illustrate the army worm's characteristic method of feeding on rye and herd's grass.

Fig. 4.

The Army Worm in Massachusetts.

The history of the army worm in Massachusetts is of more than ordinary interest, since it affords an excellent idea of the periods of time usually elapsing between the outbreaks of this insect. It is recorded* that in 1632 "the worms made extensive ravages on the corn," while 1646 and 1649 "were caterpillar years." In 1666 "the Indian corn was eaten by worms." There is of course much doubt concerning the species of insect causing the above-mentioned damage to crops, but by some it is thought to have been the army worm. Later records are more authentic; 1743, — "Millions of devouring worms in armies, threatening to cut off every green thing." 1762, — "At last, when the corn was planted, millions of worms appeared to eat it up." 1770, — "A very uncommon sort of a worm . . . ate the corn and grass all as they went above ground, which cut short the crops in many places." Of this last-mentioned occurrence of the army worm the Rev. Grant Powers has written †: "In the summer of 1770 this whole section was visited by an extraordi-

* Agriculture of Massachusetts. Chas. L. Flint, 1854.

† Historical sketches of the Coös County (N. H.), 1841.

nary calamity, such a one as the country never experienced before or since, beyond what I shall here specify. It was an army of worms, which extended from Lancaster, N. H., to Northfield, in Massachusetts. They began to appear the latter part of July, 1770, and continued their ravages until September. The inhabitants denominated them the 'Northern Army,' as they seemed to advance from the north or north-west and to pass east and south, although I do not learn that they ever passed the high lands between the Connecticut and Merrimack rivers. They were altogether too innumerable for multitude. . . . There were fields of corn on the meadows in Haverhill and Newbury standing so thick, large and tall that in some instances it was difficult to see a man standing more than one rod in the field from the outermost row; but in ten days from the first appearance of this Northern Army nothing remained of this corn but the bare stalks!"

FIG. 5

The farmers of Worcester and vicinity suffered severely from the ravages of this insect in grass lands during the summer of 1817, when it is recorded that "their progress is as distinctly marked as the course of a fire which has overrun the herbage in a dry pasture. Not a blade of grass is left standing in their rear. We are informed that about forty years ago the same kind of worm made great destruction in ploughed land, among spring grain, but particularly in fields of flax."

Of more recent occurrence are the sudden and destructive outbreaks of this pest in the years 1861, 1875 and 1880, when whole grass and grain fields were laid waste, and in some localities farmers suffered a total loss of their hay crop.

The appearance of the army worm this year seems general throughout New England, eastern New York and some parts of New Jersey. In this State its greatest damage is in localities bordering on streams, tidewater or marshes, an evidence that wet lands are the natural home of the insect.

Through the courtesy of Secretary Wm. R. Sessions I was enabled to visit infested estates at Hingham and

Revere during the early part of July and to make a study of the conditions there existing. At the Jordan farm, Hingham, the oat fields suffered the most severely, the greater part of the leaves and heads being stripped from the grain. Grass lands and pastures in the vicinity were also infested, but to a less degree. The foreman of the place, Mr. Parmalee, was advised to promptly cut all infested crops and later to furrow around these fields in order to prevent the migration of the pest. Unfortunately there was some delay in following out the last recommendation, and as a result, as soon as the oats became partly dry, the worms migrated. Active measures, however, later on resulted in reducing the numbers of the insect.

The World's End farm, Hingham, suffered nearly as much from this pest, but the devastation was checked by promptly mowing the crops. At Revere, the large Squire farm was found to be thoroughly infested, and here, as in other places, newly seeded land suffered the most. I was informed by the superintendent, Mr. A. Bart Hill, that the army worm first appeared in both the spring and fall rye fields, and that, having stripped the leaves from the grain, they next attacked the grass lands. As a result over one-third of the grass and grain crops on this estate were destroyed by the insect.

I am enabled to state, upon the authority of Mr. Frank D. Mills, Pittsfield, Mass., that the migrating masses of army worms seriously interfered with the moving of electric cars, and, in some cases, of freight trains in the vicinity of Dalton.

The cranberry crop on the Cape has suffered this year severely from the pest, the damage to the crop in the three towns of Dennis, Harwich and Yarmouth being estimated at $100,000.

Replies from correspondents indicate that a conservative estimate of the damage from the army worm to the cranberry,* grass and grain crops of the State the present year is at least $200,000. Of this amount the greater part falls upon the cranberry growers, but many farmers have lost nearly their whole hay crop as the result of the work of this insect. The damage the army worm is capable of caus-

* I am indebted to Capt. N. B Burgess of Yarmouth Farms for much interesting data concerning the ravages of the army worm in the cranberry-growing region.

ing can be no better illustrated than by reference to the celebrated "army worm year," 1861, when the loss on grass and grain crops in western Massachusetts alone amounted to over $500,000.

Remedies.

The army worm is a pest that never arouses popular attention until it is too late to prevent damage, and the fact that the insect only appears at somewhat extended intervals of time explains, in great measure, the lack of information among the farmers concerning the remedies to combat it. In this case, as in many others, prevention is better than remedy, and the occasional burning over of mowings and pastures cannot be too strongly advocated. This procedure destroys the hibernating insects. Where the army worm appears in abundance in grass and grain fields the crop should be cut at once. A furrow should then be ploughed around the infested field with the straight edge toward the land to be protected. As soon as the crop begins to dry, the worms commence to migrate, and crawling into the furrow are unable to climb up the straight side, unless the projecting grass roots afford a foothold, in which case the furrow should be deepened by spading. Holes dug in the bottom of the furrow furnish places in which the worms will collect, when they can be destroyed. Gen. W. W. Blackmar of Hingham has met with excellent success in destroying these insects by burning sawdust soaked in kerosene oil in the holes where the worms collected. A somewhat similar measure has been employed with good results by Mr. A. I. Hayward of Agawam.

Rolling infested fields has been recommended by many writers, and at my suggestion was thoroughly tried, but without anything like satisfactory results, although the ground was level and hard.

Infested corn fields may be sprayed early in the season with Paris green,* one pound to two hundred gallons of water,

* Arsenate of lead or arsenate of barium, three pounds to one hundred and fifty gallons of water, may be substituted for Paris green. Arsenate of barium is a promising new insecticide, which has been used experimentally with good results against the gypsy moth during the past summer. Its use as an insecticide was first suggested by the writer during the winter of 1895-96 as a result of investigations upon the different arsenates, and it has so far proved superior to any of the arseni-

and, if properly done, without danger to stock feeding on the stover. Where the army worm is particularly abundant it may be advisable, in order to prevent migration, to spray grass land or to burn over the fields at once. For this latter purpose the "Cyclone burner" (Fig. 6), originally designed for burning brush land infested by the gypsy moth, will be found of value. It may be made by mounting a

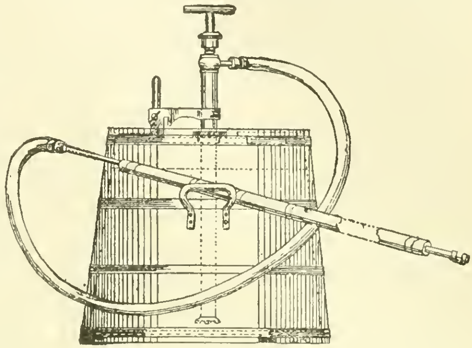

FIG. 6.

small force pump on a ten or fifteen gallon tank, and connecting the pump by means of a short piece of oil hose with a one-half-inch iron pipe at the end of which a cyclone nozzle may be attached. The pipe should be about ten feet in length and have a wooden casing for convenience in handling. The tank should be filled with cheap crude oil. The oil is forced out at the nozzle, and by igniting the spray at the nozzle a flame results, which destroys every living thing with which it comes in contact. The cyclone burner may also be used to good advantage for destroying worms collecting in the furrows.

On cranberry bogs Mr. Lounsbury * recommends wide water-filled ditches as the best means of checking the spread of the insect.

NATURAL ENEMIES.

Among the natural enemies of the army worm, birds are entitled to chief recognition. It is a well-known fact that smooth-skinned larvæ form a favorite article of the diet of insectivorous birds, and a field infested by army worms makes a feeding ground to which the birds assemble from considerable distances, and there find food for themselves

cal compounds now in use. Further experimentation, however, and, more particularly, the practical use of the poison on a large scale in the field, will be necessary to accurately determine its value.

* Bulletin 28, Hatch Experiment Station, 1895.

and young. The following list includes the birds I have seen feeding on the army worm the present summer: kingbird, Phœbe, bobolink, cow bird, red-winged blackbird, Baltimore oriole, crow blackbird, English sparrow, chipping sparrow and robin. Hens, turkeys and guinea fowls also devour large quantities of army worms.

Meadow larks, crows and flickers were seen apparently feeding upon the army worm, but I was unable to approach near enough to verify this observation. There was, however, an abundance of army worms on the ground in the places where these birds were feeding. At the Jordan farm several quail were heard in the swamp land adjacent to the infested field, and I am informed by Gen. W. W. Blackmar that these birds have been seen feeding upon the army worm at his estate. At Marshfield a flock of quail was seen to feed for several days upon army worms in an infested field. The two species of blackbirds are apparently the greatest destroyers of these insects, but the good work done by the bobolink and English sparrow deserves mention. It is, however, very doubtful if the services of the sparrow would equal those of the native birds it has displaced.

To verify observations an examination was made of the stomachs of a few birds taken in an infested field. The stomachs were found to contain army worms as follows: cow bird, remains of army worms; red-winged blackbird, three; crow blackbird, twenty-seven; six English sparrows, respectively, four, three, five, four, none, three.

The garden toad ranks high as a destroyer of army worms. These batrachians were present in all the infested fields and seemed to feed nearly continuously. Dissections of three toads revealed nine, eleven and fifty-five army worms in the respective stomachs.*

Certain parasitic flies and ground beetles usually attack the army worm and destroy large numbers, but these insects have been conspicuous by their absence in all localities visited. A single ground beetle (*Platynus sinuatus*) was noticed at Hingham feeding upon the small larvæ. Mr. A. I. Hayward of

* It is to be regretted that there is so little accurate knowledge concerning the food of the garden toad, a deficiency that I hope in some measure to supply at a later date. A large number of dissections of toads, made this year, show it to be a prime destroyer of cut worms and of nearly all the injurious insects of the garden.

Agawam, to whom I am indebted for much valuable information concerning the habits of the army worm, writes me that the greater part of the pupæ of this insect found while ploughing the infested fields were parasitized, thus showing that in some parts of the State the parasitic flies have been of material assistance in destroying this pest.

Causes Governing Outbreaks of the Army Worm.

In view of the abundance of the army worm during the present summer it may be profitable to briefly review the causes leading to such outbreaks and the influences which control the same. The army worm is an insect which appears as a pest only at extended intervals or times. This seems chiefly due to the warfare waged upon it by its natural enemies, mainly parasites, predaceous insects and birds, and also to some extent to climatic conditions.

Parasites often confine themselves to one host and their abundance is regulated by the numbers of the host, while birds as a rule seem to prefer the most abundant form of acceptable insect food. The climate affects insect increase either through the abundance or scarcity of the food supply or through conditions favorable or unfavorable to the multiplication of natural enemies.

The relationship between an insect and its natural enemies is seldom equally balanced; that is to say, the one form or the other is the more abundant in the point of numbers or more effective by reason of peculiarities favorable to its increase. Hence, in years when the army worm is not present in any considerable number its parasites are limited in their multiplication by the scarcity of the host, while the birds give their chief attention to other insects more abundant. Thus the army worm increases slowly in numbers from year to year. Finally there comes a season especially favorable for its development and the worms appear in numbers sufficient to attract some degree of attention. They are followed the next year by a more or less wide-spread outbreak.*

* I am informed by Secretary Wm. R. Sessions that from careful observations extending over a considerable period of years he has reached the conclusion that army worm outbreaks usually follow a warm, dry spring. It seems quite probable that, as pointed out by Mr. Sessions, such conditions of warmth and dryness are favorable to the emerging of the moths and the hatching of the eggs.

Then from the very fact of their great numbers there is an abundance of food offered their natural enemies, and the latter increase to such an extent as to destroy the greater part of the army worms, whereupon the insect apparently disappears. This shifting relation between the host insect and its natural enemies is best expressed by the term so frequently used by biologists, "the balance of nature," and this "balance" is the factor which controls all insect outbreaks. It would seem probable that the localities suffering most from the army worm this year will be exempt next season, although it is possible that a sufficient number of the insects may have survived in some places to cause some degree of damage. In the parts of the State where but little damage has resulted from the army worm this year there is a greater chance that the pest will be abundant next season, and here particular attention should be given to the burning over of fields. When the present outbreak subsides there probably will not be another one for several years.

The Crow in Massachusetts.

BY MR. E. H. FORBUSH, ORNITHOLOGIST TO THE BOARD.

Birds of the crow family have had a peculiar interest for the farmer for many years, both in the old world and in the new. Unfortunately for the American crow (*Corvus americanus*), it has come to have a bad name among men. Therefore, crows are proscribed by law, every man's hand is against them; mercilessly hunted, they are perforce wanderers on the face of the earth.

However much the enemies of the crow may inveigh against it, they must admit that it is a creature of superior intelligence. Its grain-loving proclivities, together with its sagacity and cunning, make it a most annoying bird to the farmer. Considerable ingenuity is required to circumvent the crow. Yet it is not naturally a supremely cautious or suspicious bird. Primarily bold and fearless, it acquires caution by force of necessity. On the Pacific coast, especially during the first settlement of the country, crows were extremely bold and unsuspicious, and this is true to-day in localities remote from civilization. Mr. H. W. Henshaw, in the "Youth's Companion," speaks of the boldness of the crows of the Pacific coast in robbing hogs, the crows alighting on the head of the hog and plucking clams from its very mouth. The writer has been informed by old settlers of what was then Washington Territory that they have seen crows so tame and so eager in their search for food that they have even perched upon the backs of squaws engaged in digging clams, and attempted to snatch the clams from under the hands of the diggers. The writer has frequently seen the north-western crows (*Corvus caurinus*) so tame that, while engaged in searching for food, they would walk about on the sand within a few feet of the observer. Yet these same

crows soon learn the significance of the sound of a gun, and the shooting of a few of their number by gunners will render the rest more wary. In the east crows have learned by association and experience to beware of the approach of man, and are considered as among the most difficult of all birds to approach. This warmess is only overcome by the pangs of hunger. In winter, when the snow lies deep on the ground and food is scarce, crows will become quite fearless in their approach to carrion. As a rule, however, crows when feeding keep one or more sentinels posted on some high tree or other point of vantage, to warn all within hearing of the approach of any possible enemy, and the warning of a sentinel is understood and heeded by all crows in the vicinity.

The intelligence of crows, like that of men, varies with individuals. Young birds, who when they first leave the nest are rather incautious, soon acquire the habits of caution taught them by experience and the warning cries of their elders.

All farmers know how difficult it is to entrap crows. Indeed, they are so suspicious of a trap that any contrivance which to their eyes resembles a trap will sometimes keep them away from corn.

Migration.

The crow as a species is a resident in this Commonwealth throughout the entire year. It is, however, quite migratory in its habits. There are times of general migration toward the south in the fall and toward the north again in the spring. During the fall and winter migrations thousands of crows may be seen trooping south or in the direction of the seacoasts and river valleys. It is probable that the crows that remain with us in winter are migrants from lands farther north. The crows appear to desert entirely some of the more northern and western portions of the State during the season of the greatest cold and snow. Mr. C. E. Bailey reports that in ordinary seasons crows leave the vicinity of Winchendon, Mass., which is near the New Hampshire line, but that they are often found farther south in Hubbardston and Princeton.

Mr. A. H. Kirkland writes that, from observations cover-

ing five or six years, and from conversation with hunters, he has learned that during the coldest weather crows disappear from some of the high lands in the western part of the State. The cause of crow migrations appears to be principally a scarcity of food. Crows remain even in Winchendon in seasons when the beech nuts are plentiful on the trees or when carrion is to be found. They are also found along the Connecticut valley throughout the entire winter, where, according to Mr. Kirkland, they assemble in great flocks in bare spots on the meadows, and catch field mice. These flocks appear to range about twelve or fifteen miles from the river, and in warm spells spread out still farther. At Mr. Kirkland's home, in Huntington, at an altitude of twelve hundred feet, and in the adjacent towns of Chester, Blandford and Chesterfield, the crows are said to remain during mild winters, roosting in hemlock forests. During severe weather they disappear entirely for a month or six weeks at a time. Near large cities, where offal or carrion may be found, they usually remain throughout the winter in large numbers. They are also found during the entire winter along the south-eastern sea-coast, where the receding tides furnish them an abundance of food, and where the ground is not so heavily and frequently covered with snow as in the interior.

Gregarious Habits.

Crows are very clannish in their habits, consorting together in flocks during the entire season, except while they are nesting, and assembling during the winter in roosting places to pass the night.

Professor Barrows has given an excellent account of the roosting habits of crows in the middle and some of the western States.* Here permanent winter roosts are found, to which the crows come nightly for many miles around and from which they go out early each morning. It is estimated that several of these roosts contain from fifty thousand to three hundred thousand crows each. This gregarious roosting habit is observed also among the crows of Massachusetts, yet the writer has never seen in this Commonwealth such

* Bulletin No. 6, United States Department of Agriculture, Division of Ornithology and Mammalogy, "Common Crow of the United States," pages 11, 12.

large permanent roosts as are described as existing in the middle, southern and western States. This may be explained by the fact that a large number of crows migrate south from the northern States and crowd into the middle and southern States, where, the winter being less severe, food is more plentiful.

The crow roosts visited by the writer in eastern and central Massachusetts were in evergreen trees, mainly in white pine woods, and there the crows were known to change their roosting places, moving from one locality to another and again returning to the original roost.

Just why the crows congregate in these winter roosts is hard to determine. It may be that they are in a measure protected, by their great numbers, from their enemies, yet they are doubtless sometimes attacked by the great horned owl in the night, as evidences of the destruction of crows by these owls are occasionally found in the snow about the roosts. Crows sometimes hold what bears the semblance of a funeral ceremony over their dead. In such a case, a crow having been shot flew some distance and fell dead upon the snow. Soon afterwards his body was discovered by another crow, whose cries immediately assembled others from all quarters of the compass, until a vast concourse was flying overhead. They gradually settled upon the trees and kept up an intermittent outcry for some time. In another case a single crow appeared to be the leader, and it was long before the immense throng dispersed.

Crows have a habit of mobbing and hectoring any animal that they believe to be an enemy. In the fall or winter months they often gather in flocks and follow hawks or owls. The appearance of a great horned owl, hawk, raccoon or fox, either dead or alive, is the signal for the gathering of a mob of crows from all the country round, when they will pursue the luckless bird or animal, if it is alive, and continually annoy it even if they do not actually attack it. At such times, amid the noise and excitement, they lose some of their habitual caution and may be more readily approached than usual. They will sometimes press an owl very closely, keeping the poor bird dodging about from tree to tree in a ludicrous manner.

Mating and Nesting Habits.

Very early in the spring, when the snow is melting, the crows indicate by their actions the approach of the mating season. Their usually harsh notes are frequently varied by very musical tones, very different in quality from the harsh "caw" commonly heard. These notes are sometimes heard well into the nesting season. Indeed, the crow has a great variety of notes, and quite a language of its own. Those who have examined its vocal organs, which are very complicated and perfect, are not surprised that crows have even been taught to speak and whistle.* On warm days, early in April, males may be seen pursuing females in swift and graceful aërial evolutions, sometimes rising high above the woods and again descending into the open spaces among the trees. Nests are soon begun, and, although they are composed largely of sticks, intermixed with coarse moss or even leaves, they are quite compact, and not unhandsome structures. The lining is made of grape-vine bark, grass, moss, hair, squash vines, feathers, rootlets or similar materials. Portions of the skins of animals, such as snakes and hares, are often found in the lining. Mr. Bailey says he has seen a crow pull up pieces of squash vines some eight feet in length and carry them to the nest. The materials used in lining the nest vary with the locality. For instance, about Winchendon Mr. Bailey has never seen a nest lined with the bark of the grape, and he says there are few grape-vines in the vicinity. In southern Worcester County the grape-vine bark is much used, while in eastern Massachusetts cedar bark takes its place.

The eggs are laid from the middle of April to July. In some cases what appears to be excessive caution is exhibited by the crow in covering the eggs with leaves when away from the nest. The writer has in two instances found fresh eggs of the crow carefully covered with dead leaves, and in one case the birds appeared soon after the nest was reached.

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* Mr. J. A. Farley had in Newton, Mass., a tame crow, that readily imitated a talking parrot.

In 1896 there was a young crow on the Enoch Russell place in Lynnfield, Mass., that could repeat a single word plainly and imitate the sound of a conversation.

Mr. F. A. Bates mentions a similar instance. The eggs vary in number from three or four to seven, and in color from a light, unspotted green or greenish blue to a darker hue, thickly covered with heavy brown and dusky spots. There is a great variation also in the size of the eggs. Probably only one brood is usually reared, but if the first nest is destroyed, the crow will build another, and where this is repeated, young fledgling crows are sometimes seen early in August.

The situation of the nest varies according to locality. When the nests and eggs are destroyed by man the crow soon learns to nest high. The tree chosen is usually a large conifer, the white pine being a favorite. Where the crow is not molested it will sometimes nest within a few feet of the ground. Mr. Bailey mentions having found nests at the height of seven or eight feet from the ground, on hemlocks, close to the trunks of the trees.

The outcry raised by the mother crow when an enemy approaches the nest is usually answered by two other crows, and the writer has frequently seen three crows in the vicinity of the nest. So far as his observation goes, this seems to be the rule. Mr. F. H. Mosher says that in south-eastern Massachusetts, where his observations were made, he has always found three adult crows about each nest during both the building of the nest and the rearing of the young. He has frequently noticed this even when they were undisturbed. During the building of the nest one would carry most of the sticks and the others would follow back and forth with more sticks.

Mr. Bailey speaks of an instance where a pair of these birds which were raising young were shot, and another crow fed the young. The female was first shot on the edge of the nest; a few days later the male was shot at the same place. Seven days later the young were alive and flourishing, and a third crow was observed to feed them. These young birds were finally reared. There is usually an excess of male birds, and the presence of bachelor birds in the vicinity of the nests may be offered as an explanation of these facts, or polygamy may be possible. This is a phase of the crow's life history which it might be well for some

one to investigate who can devote the necessary time to the subject.*

The female is said to perform the duties of incubation, but the male bird is a gallant defender and a good provider, exhibiting qualities which are always commendable in the father of a family. As soon as the young are able to leave the nest, they are sustained, watched, guarded, admonished and taught by both parents, and the family remains together as long as the young require any attention.

Digestive Capacity of the Crow.

To obtain a definite understanding of the amount of good or harm the crow is capable of doing, it is essential to know what amount of food it is obliged to consume in order to maintain its strength. Mr. E. A. Samuels says that he has kept specimens in captivity, and has, by actual observation, proved that at least eight ounces of animal food, such as frogs, fish, etc., are eaten daily by them.†

To determine how much food the fledged young require, the writer had two young crows confined in a large pen or cage. These crows were kept and fed until September 2, when one was accidentally killed. The other was kept until September 14. These crows were fed animal and vegetable food in about equal proportions, and the amount of each eaten by them was surprising. Either appeared to be eaten with nearly equal avidity, although at times a distinct preference was shown for animal food. The animal food consisted of the larger insects, such as grasshoppers, crickets, borers and beetles; also of snakes, frogs, mice and meat. The vegetable food consisted largely of tomatoes and green corn. It soon became evident that the crows were not being fed sufficiently, as they did not thrive.

From August 21 until their death the crows were each weighed daily, and the food given to them was also weighed. On September 2 they were each weighed, the larger weighing sixteen and one-half ounces and the smaller fifteen ounces.

* Mr. C. J. Maynard, in his book entitled "The Birds of Eastern North America" (1896), says, on page 456, that sometimes three crows are engaged in building one nest, and that all three will remain about it until the eggs are hatched.

† E. A. Samuels, "Birds of New England," page 359.

When fed less than eight ounces each they either did not increase in weight or fell off, and it was not until each crow was fed ten or more ounces that their weight increased. If the amount given the crows was largely reduced during any one day there was a corresponding falling off in the weight of the bird. On September 13 the larger crow weighed eighteen and one-half ounces. On that day it was given only two ounces of tomato, fifty-six grasshoppers, twelve crickets and a little grain, in all some three ounces of food. The next morning it had lost one and one-half ounces in weight.

As a preliminary to the solution of some of the problems which come up during stomach examinations, a knowledge of the processes of digestion and their possibilities in the species under consideration is indispensable. Crows swallow large quantities of sand, gravel, etc., to aid in the digestive process. The muscular walls of the stomach contract upon these hard substances, and thus the food is ground, crushed and masticated, so to speak, in the stomach.

To determine the length of time required for digestion, two methods were used: first, feeding substances more or less indestructible, such as the eggs of the gypsy moth (*Porthetria dispar*), and afterwards examining the excreta to determine how soon the eggs were dropped; second, an examination of the stomachs of the dead birds. Ten experiments of the first class and two of the second were made upon the two birds.

From the time of the beginning of the feeding period to the time when the first eggs were dropped in the excreta averaged one hour, twenty-nine minutes and forty-five seconds, or approximately one and one-half hours. The minimum time was forty-eight minutes and the maximum time was an hour and fifty-four minutes.

When we consider that the indigestible substances are usually retained in the stomach much longer than those which are more readily digested, it will be seen that the digestion of the bird is remarkably rapid. The crow which was accidentally killed had fed freely upon grasshoppers for twenty minutes, and was killed ten minutes after the close of the feeding period. An examination of the alimentary canal

showed the stomach to be quite full, but less than fifty per cent of the contents were in a condition to be recognized. These were more particularly the hard parts of the wings, thoraces and legs. The strongly chitinized pronota and hind femora of the grasshoppers offered the most resistance to the digestive process. The other fifty per cent of the stomach contents were so finely divided that one would hardly care to express a positive opinion as to its identity.

The second crow was killed thirty minutes after the close of the feeding period, which lasted four minutes, in which time the bird ate six crickets and eleven grasshoppers. Twenty-five per cent of the stomach contents was unrecognizable.

Mr. Kirkland, who made the examinations, says: "I think from what we have seen that we would expect to find the stomach emptied in about one to one and one-half hours."

The softer or more liquid food must evidently be digested in a very few minutes and rapidly assimilated.

The Food of the Crow.

The investigation of the food of the crow, which was begun in 1885 by the direction of the ornithologist of the U. S. Department of Agriculture, is by far the most important examination of this bird's food ever undertaken. A preliminary statement of the results of an examination of ninety-eight stomachs (eighty-six of the common crow and twelve of the fish crow) was published in the annual report of the Department of Agriculture for 1888.

In summing up the evidence obtained from all sources Professor Barrows says: "The careful examination of large numbers of stomachs and the critical study of the insect food of the crow may change materially the present aspect of the question; but, so far as the facts at present known enable a judgment to be formed, the harm which crows do appears to far outweigh the good." *

A final report on the crow's food is embodied in a pamphlet issued by the department in 1895, entitled "The

* Annual Report United States Department of Agriculture, Report of the Ornithologist and Mammalogist for the year 1888, page 525.

Common Crow of the United States." This report is based upon the examinations of the contents of nine hundred and nine crows' stomachs and much information gathered from correspondents.

Most of the material except the insects found in the stomachs was examined by Prof. F. E. L. Beal, assistant ornithologist, and important assistance was also rendered by Dr. A. K. Fisher. The insect material was examined and reported on by Mr. E. A. Schwarz. Professor Beal received valuable assistance from Dr. George Vasey, Mr. F. V. Coville and Mr. F. A. Lucas. The names of all these eminent specialists form a sufficient guaranty of the accuracy of the work done.

In summing up the notes for and against the crow, Dr. Merriam, chief of the Division of Ornithology and Mammalogy, says in his letter of transmittal: "The most important charges brought against the crow are: (1) that it pulls sprouted corn; (2) that it injures corn in the milk; (3) that it destroys cultivated fruit; and (4) that it feeds on the eggs and young of poultry and wild birds. All of these charges are sustained by the stomach examinations, so far as the simple fact that crows feed upon the substances named." But Dr. Merriam maintains that the stomach contents showed plainly that a large proportion of the corn eaten is chiefly waste corn; also that the loss in case of cultivated fruits is trivial, and that the same is true in regard to the eggs and young of poultry and wild birds. He also says that, as an offset to the bad habits of the crow, it should be credited with the good done in destroying noxious insects and other injurious animals. In summing up the benefits and losses from the crow, Dr. Merriam says: "It is clear that the good exceeds the bad and that the crow is a friend rather than an enemy to the farmer." If we are to accept this conclusion as the correct one, we must believe that the opinion of Professor Barrows, as quoted above, was based on insufficient or incomplete data.

In Massachusetts the chief complaints by farmers in regard to the crow relate to its destruction of corn. It must be admitted that the crow destroys considerable quantities of corn soon after it is planted, either by picking or digging

up the corn or by pulling up the young shoots to get at the kernel. We have heard some complaint also in regard to the destruction of corn in the ear. It must not be inferred, however, that when crows are at work in the corn field they are always eating corn. On the other hand, crows have been shot in Massachusetts corn fields apparently engaged in pulling corn, whose stomachs, when examined, showed no trace of grain, but were largely filled with the white grub of the May beetle (*Lachnosterna fusca*), and various cut worms.

Crows are undoubtedly somewhat destructive to fruit, as they have been observed to eat apples, wild grapes and both wild and cultivated cherries.

Farmers when engaged in planting have occasionally observed crows digging up sections of potatoes and carrying them away from the hill. Mr. Mosher reports having seen crows in the fall in the act of carrying off such potatoes as were not entirely covered by the soil. Several reports have also been received of the destruction of the eggs and young of poultry by crows; and in these cases the observers actually saw the crows in the act. Mr. Farley says that in southern Bristol County, near the sea-shore, crows have been seen to kill well-grown chickens and are very troublesome. It seems probable that certain individuals among crows become addicted to the habit of destroying the eggs and young of poultry and small birds. It would appear from all the evidence obtainable, that in this region much harm may be done by such crows by the destruction of wild birds and their eggs. Some crows appear to be inveterate nest robbers. In Florida, in New England and on the Pacific coast the writer has observed that, where herons or sea fowl breed in large numbers, the crows congregate for the purpose of robbing their nests. In the "rookeries" of several species of Florida herons, in those of the night herons of New England and in breeding places of gulls and guillemots on the Pacific coast, crows appear to be always on the watch, and whenever either herons or sea birds leave their nests the crows hasten at once to feed on the unprotected eggs. Piercing them with their bills, they quickly eat or suck out the contents. This trait of the crow is well known to all observing

ornithologists, and it is probable that most species of birds whose nests the crow can readily find and reach suffer at one time or another from such depredations. Although the writer has never seen the crow actually taking young birds from the nest, he has been told by many trustworthy observers that they have frequently seen the crows in the act. Early in the morning, before people are astir, the crow will approach the farm-house, robbing the nests of small birds in the orchard and about the buildings. Those of the smaller birds whose nests are largest and most exposed, such as the robin, the red-winged blackbird and some of the thrushes, probably suffer most. Mr. Mosher says that he has seen the nests of smaller species, such as the chipping sparrow and red-eyed vireo, robbed by the crow. Those birds whose nests are most conspicuous suffer most frequently from its attacks. A vireo's nest which was placed within thirty yards of a crow's nest, but carefully concealed under the leaves, was not troubled by the crows. A nest of the ruffed grouse was left unmolested, although it was within a hundred yards of a crow's nest. Mr. Bailey speaks of another which was placed immediately beneath a tree that contained a nest in which a pair of crows reared their young, the grouse rearing her young unmolested meanwhile. It seems probable that all these nests must have been discovered by the crows sooner or later. Whether these particular crows had not become addicted to the nest-robbing habit, or whether they preferred to dwell at peace with their neighbors, must be left to the reader to conjecture.*

In the preliminary report on the food of crows, published in 1888, and based on the results of dissections of only eighty-six stomachs and information received from upwards of five hundred persons, Dr. Barrows writes as follows in regard to the destruction of the eggs and young of wild birds by the crow: —

"No observant person will deny that the crow does serious damage to the eggs and young of wild birds. The instances

* A correspondent, Thomas Proctor, Esq., Brooklyn, N. Y., writes that a pair of crows had a nest in Prospect Park in that city a few years since, and that a robin's nest was placed on the top of a post within seventy-five feet of the crow's nest and in plain view; the young robins were not disturbed by the crows, though they were frequently exposed during the absence of their parents.

of such depredation which have come within the knowledge of most farmers or other persons living in the country are far too numerous to leave a shadow of doubt on this score in any unprejudiced mind.

"Yet for every instance of such robbery witnessed by man, thousands must take place without his knowledge. Persecution by crows is doubtless a very large factor among the influences which cause so many birds to crowd about human habitations during the nesting season; and yet the relentless crow follows them even to the eaves and window-sills of houses, taking their eggs and young in spite of every precaution.

"The evidence on this point, contributed by our observers during the past few years, is replete with accounts of such forays, and the only wonder is that robins, thrushes, blackbirds and many other species continue to rear any young at all." *

In the later report, published in 1895 and based mainly on the examinations of a much larger number of stomachs, Professor Barrows seems inclined to minimize the harm done by crows in this manner, and Dr. Merriam regards it as trivial.

Professor Barrows states in the later report that it seems probable that not more than one crow in twenty becomes addicted to this sort of stealing.† While this may be true, the avidity with which crows so often attack birds' eggs and young and their eagerness to be on the scene as soon as possible whenever an opportunity for eating eggs is presented, would lead one to believe that most crows are addicted to such stealing whenever eggs are plentiful and can be readily found. Numbers of sea birds breed on a small, treeless island in the San Juan Archipelago, Puget Sound. Immediately upon their being disturbed or driven off by white men or by the Indians, crows flock from the islands in the vicinity to feed upon the eggs or young of the sea fowl. The writer found on this island a nest of the north-western crow, which was built in a hollow dug in the earth at the

* Annual Report United States Department of Agriculture, Report of the Ornithologist and Mammalogist for the year 1888, page 513.

† "The Common Crow of the United States," page 47.

top of the rock, and protected only by a few scattered grasses and cacti. This nest contained three young crows and was guarded closely by the parents. The only reasonable explanation of the breeding of the crows upon the earth upon the top of this barren, rocky island seemed to be that their favorite food, the sea birds' eggs, was more accessible to them there than elsewhere. Being located on the island, they were enabled to reach the nests of the sea birds far in advance of other crows, which must come from other islands situated a mile or more away. On these other islands there was a great forest growth; vegetation was far more plentiful, there were bars bare at low tide, and there was in every way a better opportunity for nesting and for securing animal food, with the exception of the sea birds' eggs, than on the rock where the crows bred. Stomach examinations cannot safely be relied upon entirely to determine the amount of eggs or young birds eaten by the crow. The rapidity with which such substances as the contents of eggs are digested by the crow suggests the probability that egg contents cannot often be recognized in the birds' stomachs. Indeed, Professor Barrows reports that the remains of eggs found in the stomachs of young birds consisted only of pieces of shell.* As the crow usually makes but one hole in the shell and sucks or eats out the contents, it is not likely to swallow much of the shell, and such small portions of the shells of the eggs of small birds as are swallowed soon become so finely disintegrated in the stomach as to be unrecognizable.† The softer parts of nestling birds, when eaten by the crow, would soon disappear from the stomach, and the bones, being soft, are digested.

According to the stomach examinations made, that portion of the food consisting of the eggs and young of wild birds forms hardly one per cent of the food of the crow for the year. Now, if we assume that the crow eats only five ounces per day, or one-half the amount required by our young birds, one per cent of the food of the crow for the

* "The Common Crow of the United States," page 47.

† It is but just to say that Professor Beal informs me that from his observations and dissections he has been led to believe that the crow usually swallows some egg-shell when eating or sucking eggs, and also that pieces of dry egg-shell are frequently swallowed by the crow.

year would amount to eighteen and one-fourth ounces. Assuming that the young birds or eggs eaten by the crow average one ounce each in weight, which is perhaps a high average, we have eighteen and one-fourth birds or eggs to each crow as its record for the season. If we allow only ten families of crows of five each for one of our larger western townships, the fifty crows would destroy over nine hundred young birds or eggs. Whether such destruction should be regarded as "trivial" seems, in the present state of our knowledge on the subject, largely a matter of opinion. When, for reasons previously given, we consider that in all probability the stomachs examined did not give a full record of the devastation committed in this manner by the crow, it seems possible that the bird may deserve the bad name it has been given as a destroyer of the young and eggs of other birds. But it is difficult, if not impossible, to determine, at least by stomach examinations of the crow, whether the birds that are destroyed, or those resulting from the eggs even, would have been of sufficient economic value, if allowed to live, to more than offset the balance in favor of the crow for services rendered by destroying insects and injurious mammals.

It is evident, from the excellent report made by Mr. E. A. Schwarz on the examination of the insect food contained in the crows' stomachs obtained by the Department of Agriculture, that the crow would be a great blessing to the farmer during the spring, summer and early fall, were its diet confined to insects.* Its services in destroying grasshoppers and May beetles and their progeny, the destructive white grub, are not generally appreciated. Add to them the destruction of cut worms, click beetles and weevils and other destructive insects, and the farmer is well able to spare such of his insect friends as the crow destroys, *i. e.*, the ground beetles and soldier bugs. We must, therefore, agree with Mr. Schwarz that "the facts, on the whole, speak overwhelmingly in favor of the crow, and, taken alone, would be at variance with the prevalent opinion hitherto held, and yet held, regarding the economic status of the crow as an insectivorous bird." Mr. Schwarz makes some

* "The Common Crow of the United States," pages 56, 67.

rather sweeping generalizations, however, based on the results of the examinations of stomach contents, which do not agree with recorded observations carefully made in eastern Massachusetts. He says: "The insect food of crows is almost exclusively composed of terrestrial species, *i. e.*, such as are found on the surface of the ground or hide during the daytime at the base of plants or under the various objects lying on the surface; or such as live in the dung of domestic animals, in decaying vegetable and animal matter or underground." And again: "The almost complete absence of the numerous arboreal insects of all orders, *i. e.*, such insects as are to be found on or which live on the trunks, limbs or leaves of trees and shrubs, indicates that the birds when sitting or resting on trees do not pick up insects."

To those who have observed crows feeding in summer in orchards or forest trees for considerable periods on some of the larger caterpillars these seem rather remarkable statements. To such observers the almost complete absence of such food from the stomachs examined would merely justify the conclusion that most of the crows were shot while, or soon after, feeding in fields, gardens, pastures, prairies or other open land. It seems most astonishing that the examination of so many stomachs should yield the remains of so few arboreal insects. While all who have closely observed crows must agree that much of their feeding is done on or near the ground, yet it must be admitted that in the more wooded districts of Massachusetts, at least, in the late spring and during a part of the summer the crows feed much in and among trees in which insect food is plentiful, and that, although they may destroy some fruit in the orchards, such as cherries and apples, the chief sustenance they obtain in summer from the trees consists of insects.

The past two seasons, 1894 and 1895, have been "cankerworm years" in eastern Massachusetts, and the two species of canker worms, *Anisopteryx vernata* and *Anisopteryx pometaria*, have been very abundant not only in the orchards but also among the elms, both in the parks and woods. Those who have watched the smaller warblers and sparrows feeding on these caterpillars are aware that many of them escape the

birds by spinning down from the twigs as they are disturbed by the movements of their pursuers. The crow, however, takes advantage of this habit of the worms. Its keen eye marks the brown and almost leafless branches of the orchard, and, as with slanting flight and sudden swing up wind the sable bird flaps heavily down upon a bough, the canker worms, startled by the shock, spin down from the branches and twigs in dozens, and the crow, moving clumsily, if you will, from branch to branch, and stretching its neck after the manner of a hen engaged in a similar occupation, quickly gathers the suspended canker worms into its rapacious maw. Gentry refers to *Anisopteryx vernata* as one of the species sought by the crows to feed their young.* Not only does the crow destroy the smooth-skinned larvæ, such as *noctuids* and *geometrids*, but it seeks out such hairy larvæ as those of the tent caterpillar moth (*Clisiocampa americana*). These the crow can readily secure in large numbers by tearing open their nests when the caterpillars are gathered within. Crows have been seen to visit these nests and empty them of their contents. This habit has been recorded elsewhere.†

In the investigations of the natural enemies of the gypsy moth, undertaken by the Massachusetts State Board of Agriculture, the crow has been found one of the most useful birds. It destroys not only the caterpillars but also the pupæ in large numbers. ‡ These observations, made in 1895, have since been supplemented by more complete and convincing investigations made during the present year. Wherever the caterpillars of the gypsy moth appear in such numbers in the woods as to strip the trees of their foliage to a noticeable degree, crows seem to be attracted from the neighboring woods by the abundance of insect food, and they frequently have been seen to lead their fledged young to such localities. These families of crows may often be found in the early morning feeding upon the larvæ and pupæ of the gypsy moth. Like the jays, shrikes and titmice, they destroy many insects which they do not eat, al-

* "Birds of Eastern Pennsylvania," 1877, vol. II., page 5.

† See Massachusetts Crop Report, July, 1895, "Birds as Protectors of Orchards."

‡ Report of the State Board of Agriculture on "The Gypsy Moth," 1896, page 217.

though they eat greedily. In such cases it will be noted that stomach examinations would not show the full value of the birds as caterpillar eaters.

In view of the well-known difficulty encountered in approaching crows, some doubt may be expressed as to the accuracy of these observations. This work has been so carefully done, however, that there can be no possibility of mistake. The caterpillars and pupæ of the moth are quite large and conspicuous, and the birds have been observed at such close range that in some cases the number of insects they ate might be readily counted. Mr. Bailey carefully concealed himself early one morning in a swamp in Malden, Mass., for the purpose of watching birds that fed on the caterpillars and other forms of the gypsy moth which swarmed on the near-by trees. No crows came at first, but soon two adults and their four young appeared, and most of them remained feeding on the moths for nearly an hour and until an incautious movement of the observer startled them, when they left and did not return while he was there. The caterpillars have the habit of clustering in sheltered situations on the trunks of trees and under sides of branches during the day. A crow would approach one of these clusters and eat some of the caterpillars and pupæ, pecking and killing many more than it ate, dropping their mutilated forms on the ground. The crows all seem to prefer the pupæ to the caterpillars, possibly on account of the disagreeable character of the larval hairs. For a portion of the time the crows were picking up pupæ as rapidly as a domestic fowl picks up corn. One of the young crows while engaged in feeding came within ten feet of the observer. Their feeding could be readily seen, as the caterpillars had stripped nearly all the leaves from the trees. They moved through the trees about and above the observer during most of the time, although the old birds flew away for a time, returning later. The young birds appeared to attack the caterpillars and chrysalids more eagerly than did their parents.

The crows not only search the crevices of the trunks of the trees, but pry about beneath the limbs, showing that they quite readily adapt themselves to feeding in the trees. Not only do crows frequent the more open places where the

caterpillars have stripped the trees, but they are frequently seen feeding in woods in localities where larvæ are not so plentiful, and undoubtedly pick up many species during the season when the various caterpillars are found upon the trees. On one occasion Mr. Mosher saw a crow search out and eat four forest tent caterpillars (*Clisiocampa sylvatica*), after which it moved from tree to tree apparently engaged in the same occupation.

If the habits of the crow in Massachusetts are not exceptional, then it must be admitted that the crow obtains much insect food from trees during a portion of the summer. This habit of caterpillar eating must be set down to the credit of the crow in this region, and is certainly one strong point in its favor.

The Protection of Crops.

It would seem that in Massachusetts greater injury is done by the crow to the corn crop than to any other, and it has been a time-honored custom to place effigies supposed to represent the human figure, or dangling strings, dead crows or other "scarecrows" in corn fields. Though these artifices often keep crows away from corn, they do not always succeed in accomplishing the object, and their use is not to be generally recommended, even if successful; for by driving the crows away from corn fields the farmer loses their services as a destroyer of noxious insects. Fields of corn located at a distance from farm buildings and those near woods in which the crow nests are likely to suffer most if unprotected. If the crows can be prevented from attacking the corn when first planted or when it first appears above the surface, there seems little danger that they will feed on the corn at all. For many years farmers have been in the habit of soaking their seed corn in water, to cause it to germinate quickly, and then smearing it with tar. The taste of tar is known to be repugnant to crows and blackbirds, and will prevent them from pulling the corn; for when they have pulled a few stalks they apparently conclude that all the corn is tainted in the same way, and will take no more from that field. The receipt commonly used is to place a half bushel or more of

soaked corn in a vessel and enough coal or gas tar to give each kernel a thin coat, when the mass is stirred with a stick. After this, plaster of Paris or wood ashes are stirred in until the corn is well coated with it. When this is done, however, the planter cannot be used, and the corn must be planted by hand.* For this reason many prefer to feed the crows with soaked corn during the time when the newly planted corn is subject to their attack. When this plan is followed the corn may be planted with the planter and a little soaked corn scattered daily around the borders of the field. This plan is said to give good satisfaction. In this way a few quarts of corn have been found sufficient to prevent the depredations of the crow in a corn field of eight or ten acres.

If the common king birds (*Tyrannus tyrannus*) are not driven away from the farm or field, because of their real or supposed depredations among the bees, they will keep the crow away from the vicinity of the farm buildings and fruit orchard, where, if the smaller birds are encouraged to nest, the services of the crow will not be usually needed during the nesting season. The king birds protect not only their own eggs and young, but those of wild birds and poultry.

Crows may be readily poisoned by soaking corn in strychnine, and after a few have been poisoned in this way the others usually forsake the field. But such uses of poison

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* If corn is properly treated and afterwards dried, it can be used with a planter. The following extracts from letters from correspondents show how they prepare tarred corn to be planted with a machine: —

"Put one-fourth to one-half bushel of corn in a half-barrel tub; pour on a pailful of hot water or as much as is necessary to well cover the corn; dip a stick in gas tar and stir this briskly in the corn; repeat until the corn is entirely black; pour off onto burlap (bran sacks are excellent); spread in the sun and stir two or three times during the day. If this work is done in the morning and the day is sunny, the corn will be ready for the planter the next day without any other care. The hot water softens the tar so that only just enough will adhere to the corn, and the corn is completely glazed by the sun. This is by far the quicker way of tarring corn, is harmless and effectual, and I have for years planted corn treated in this way with a machine." (Ethan Brooks of West Springfield, Mass.)

"I have never had any trouble in using the planter. I usually, however, tar the corn a day or two before planting and spread it out to dry. My method is to put a bushel of corn into a barrel; pour hot water into it to warm it; drain off the water; take a stout stick, dip it into the coal tar; stir up the corn and then roll the barrel until the corn is all coated. In this way very little tar is used. Then I throw in a few handfuls of land plaster, roll it around and spread the corn out to dry. It does not interfere in the least with the working of the planter." (J. N. Pardee, South Billerica, Mass.)

are prohibited by law, and the destruction of the crow or its exile from the field are not usually to be desired. Scarecrows of various kinds may be used if necessary when corn is in the milk, to keep crows from the fields.

Is the Crow a Friend?

The question, Is the crow a friend or an enemy to the Massachusetts farmer? can only be answered by an exact knowledge of what constitutes its food at all hours of the day, at all seasons of the year and under changing conditions. This must be supplemented by an exact knowledge of the economic value of the plants and animals on which it feeds. Therefore, to answer this question by a scientific investigation with even approximate accuracy would be the work of years. The crow, unlike many other birds, is almost omnivorous, feeding on anything, living or dead, which it can utilize as food. A species which can adapt itself to all kinds of food is likely to remain a stable factor in any *fauna*, as it is far better able to maintain its normal numbers without great fluctuations than a bird which is by nature obliged to depend on a more limited diet. The omnivorous species, always finding sustenance, either vegetable or animal, are enabled to maintain their numbers, forming a standing army always at hand to attack any great outbreak of injurious mammals, reptiles or insects, or even to clear the land of carrion.

If our experiments are conclusive, young crows require more than half their own weight of mixed animal and vegetable food daily. If in computing the amount of food eaten by adult crows we assume that they can live on half this amount, or only five ounces of food per day, it is plain that one thousand birds would consume three hundred and twelve pounds daily. If their food on any one day consisted almost entirely of field mice, injurious insects, wild berries and seeds, they would be, on that day, very beneficial to the farmer. If, on the other hand, their food on a certain day consisted of toads, the young or eggs of poultry and wild birds, corn or other grains and cultivated fruit, they would be, on that day, very injurious to the farmer. The question as to whether the crow is beneficial or injurious

depends entirely on how the account balances at the end of the year.

The crow cannot fail to be very valuable to agriculture if its food habits are on the average more beneficial than injurious. If, however, the balance is upon the other side, the bird may become a serious pest. If in times of plenty its numbers increase beyond all reasonable bounds, it is likely to grow injurious in proportion to its numbers. When crows become so plentiful in any locality that they cannot find, in the fields and woods, a sufficiency of animal food for their young, they are likely to turn their attention to poultry and wild birds, and also to do more injury to farmers' crops.

In summing up the evidence for and against the crow, it must be admitted: first, that the crows injure the corn crop to some extent, and some other crops slightly; second, they are somewhat destructive to the eggs and young of poultry and wild birds; third, they distribute the seeds of poisonous plants; fourth, they destroy some beneficial insects, probably killing more than they eat; fifth, they eat large numbers of frogs and toads. On the other hand: (1) the service of the crow in destroying noxious insects can hardly be overestimated; (2) crows are of great service in destroying field mice and other small mammals; (3) crows are useful to some extent as scavengers.

While it may be impossible with the data at hand to determine the exact economic status of the crow in Massachusetts, the question asked at the beginning may be answered in a general way. The wholesale destruction of crows is said to have been followed by a remarkable increase of injurious insects, and from what is now known about the crow's food we may conclude that, unless these birds become unduly numerous, and therefore destructive, they are likely to be of great service to the farmer. It will pay the farmer to sacrifice some portion of his products to the crow, provided he uses care that the cunning bird does not overreach him in the bargain.

The Babcock Milk Tester; its Value and Importance to the Producer and Dealer in Sale Milk.

BY MR. GEORGE M. WHITAKER, ACTING EXECUTIVE OFFICER OF THE DAIRY BUREAU.

The dairy literature which the Babcock milk tester has suggested has been almost entirely in the interests of the butter maker. Differences in the butter product of different cows have been emphasized, and many cows have been shown to be unprofitable; this has enabled the dairyman to weed out inferior animals and secure a greater production of butter at less cost and, in some cases, with fewer animals. This test has also made possible a more careful study of the by-products of the dairy (skim-milk and buttermilk), which has helped the butter producer to prevent waste and to carry on his work with greater profit.

But this valuable process can be of much service in the sale milk business, especially where large cities have made the production of sale milk an industry of great magnitude. Though the farmer who produces milk for market may not find the Babcock tester of as much value as does his butter-making brother, yet it can be of more importance on the milk farm than has been commonly supposed. These milk testers are now so cheap that they are within the means of any one who has considerable interests at stake in the producing, selling or buying of milk. They can be of great service to the milk seller, and even to the purchaser, as well as to the producer. By the use of the Babcock tester hotels, restaurants, public institutions and other users of milk can ordinarily be assured of the quality of the milk they buy. With the Babcock tester the retail peddler can keep track of the quality of the milk he sells, and thus ward off all fears of inspectors; he can, if he wishes, guar-

antee a certain specific quality. If he can secure supplies of extra quality, and can find customers who are willing to pay extra price if the quality is assured, he can warrant that the customer will receive what he pays for. With the Babcock tester the farmer can know what he is selling. If he ships to the Boston contractors, he can, by the use of the Babcock tester, remove much of the mystery which has hitherto enveloped the statute standard. He can keep supervision over the quality of his milk sales and can know whether he is sending standard milk or not. If he receives complaint from the contractors, he has proof from his own tests of the kind of milk that has left his farm.

In order to understand the use of the Babcock tester in the sale milk business, a few fundamental principles about milk must be understood. First, the milk of individual cows varies from day to day. If the milk of a cow were to be analyzed every day, and the results of those analyses represented pictorially by a line which should go up as the quality of the milk increased, and *vice versa*, the line would, speaking in a general way, be something like a row of V's: VVVVVVV.

This is a somewhat exaggerated statement, because the irregularities will not be as uniform as is indicated by the above, and because, as the period of lactation increases, the amount of solids in the milk will increase; but in a general way the above is a representation of the quality of milk from day to day of individual cows under normal conditions. Ordinarily this variation is less than one per cent, and when the quality goes up one day it usually comes down about as much the next day. Second, when the milk of several cows is considered we find that these variations in the different animals are not all alike at the same time, but where the milk of one cow shows an increase, this increase may be offset by a decrease in the quality of milk of another cow. Hence the mixed milk of a herd is more constant in quality than the milk of single animals, and does not vary much from day to day. Where the conditions of barn and feed are such that the cows can have an adequate amount of food under comparatively uniform conditions, when they are neither too cold in winter, nor obliged to tramp long

distances in a dry pasture under a burning sun and annoyed by flies, for summer rations, the quality of the mixed milk of a herd is quite uniform the year round.

Third, variations in the quality of milk are largely due to variations in the amount of fat. The amount of the other solids is comparatively constant in different kinds of milk. While we frequently find a variation of 3 per cent or over in the fat, the variation of the other solids is usually less than 1 per cent. Ordinarily the amounts of solids not fat and fat increase together, though not in the same ratio; and speaking in a very general way, ordinary milks have about the following general composition: —

Fat.	Solids not Fat.	Total.	Fat.	Solids not Fat.	Total.
2.50	8.75	11.25	4.00	9.40	13.40
3.00	9.00	12.00	4.50	9.50	14.00
3.50	9.25	12.75	5.00	9.60	14.60
3.70	9.30	13.00	5.50	9.75	15.25

We do not claim that this is absolutely accurate, but it is approximately so, and near enough for the purposes of the use of the Babcock tester in connection with the sale of milk of the statute standard. The statute standard of milk seven months in the year is 13 per cent of total solids, and from the above table we see that such milk would ordinarily have about the following composition: —

Fat, ...	3.70
Solids not fat, ...	9.30
Total, ...	13.00

Five months in the year the statute standard is 12 per cent, which, if normal, is made up about as follows: —

Fat, ...	3.00
Solids not fat, ...	9.00
Total, ...	12.00

These facts are embodied in the statute standard as passed by the Legislature last winter, which says: —

In all prosecutions under this chapter, if the milk is shown upon analysis to contain less than thirteen per cent. of milk solids, or to contain less than nine and three tenths per cent. of milk solids exclusive of fat, or to contain less than three and seven tenths per cent. of fat, it shall be deemed for the purposes of this act to be not of good standard quality, except during the months of April, May, June, July and August, when milk containing less than twelve per cent. of milk solids, or less than nine per cent. of milk solids exclusive of fat, or less than three per cent. of fat, shall be deemed to be not of good standard quality.

The Babcock tester tells only the amount of fat in milk, but from the above it will be seen that the fat is the element which varies the most, and that the amount of fat is practically the key to the situation. Milk having 3.70 per cent of fat will be up to the statute standard of 13 per cent of total solids. Milk that tests 3.50 per cent of fat is on the danger line, but so near all right that under ordinary circumstances it would probably pass muster and would not get the seller into trouble, as a certain amount of leniency is necessarily allowed in all statutes of this kind. If a milk has 3 per cent of fat it will be satisfactory during the five months of the year in which the standard is 12 per cent of total solids. A man with a herd of Jerseys or Guernseys whose milk tests from 4.50 to 5 per cent of fat would be safe in guaranteeing milk of 14 per cent of total solids. If he lives where there are people who are willing to pay an extra price for an article of extra quality, he will run no risk in guaranteeing his milk to have 13, 14 or 15 per cent of total solids, as the case may be, and he can be assured that he is keeping up to the required quality by using his tester.

In the actual use of the Babcock tester it will not be necessary to go to the trouble and labor of testing milk every day. Where the herd remains unchanged and without any variation in conditions, and the milk of the different animals is thoroughly mixed, a test every three or four weeks will usually be sufficient to keep an accurate knowledge of the situation. On purchasing a new cow or on having any considerable number calve near the same time, more frequent tests for a short time would be desirable. In case of trouble a daily test of each animal might be necessary for a

week or so, but this would be an exceptional condition of affairs. An intelligent and experienced milk producer, having substantially the same cows month after month, will very soon get such an acquaintance with the quality of the milk of his herd as will enable him to keep close track of it with only occasional tests.

Farmers shipping milk to Boston occasionally receive notifications that their milk is below the required quality. When the farmer is testing the milk at intervals, and watching the condition of his cows and their feed, he will know what quality of milk he is furnishing as well as the contractors, and when a complaint is received he will know either that it is just, that some one has been tampering with the milk or that there has been improper sampling at the other end of the line.

It is now generally understood by those who have studied the question of milk production the most exhaustively and the most accurately, that quality in milk is due more to the animal than the feed (assuming of course that under all circumstances the animal has enough to eat). Hence, if milk is deficient in total solids under ordinary conditions it is because there are poor cows in the herd. These must be found out and their places filled with better ones, or else enough better ones must be added to the herd to bring up the average. Here is another use for the Babcock tester. By testing the different cows in his herd, and by the use of a few figures, the farmer can tell what to do to improve the quality of the milk he sells, and, if necessary, to bring it up to the standard.

To illustrate: suppose a farmer who is producing ten cans per day for the Boston market gets word that his milk is down to 12 per cent. As we have said, there is usually no great variation in the quality of the mixed milk of the same herd, and if the man has been using the tester he knew even before the contractors that he was shipping low-grade milk. But having received this notice he starts at once to test the different cows of the herd, and at the outset he finds that one large cow, in the flush of new milk, is giving two cans per day, which has only two per cent of fat. She contributes one-fifth of the whole supply. Now if he should replace

that poorer milk with twenty pounds that has 4.50 per cent of fat it would raise the average to 3.50 per cent, and though such milk would not be safely over the danger line, an improvement of three-fourths of one per cent would be shown (the milk having gained from 12 to about 12.75 per cent of total solids) and it might be accepted.

To illustrate this principle further: a mixture of half and half of 3 per cent and 5 per cent milk would test 4 per cent of fat, and have approximately 13.25 per cent of total solids.

Again, take one-third of the 5 per cent milk and two-thirds of the 3 per cent. The mixture would have 3.66 per cent fat, and would have approximately 13 per cent of total solids.

In institute work, when this principle is explained, the question often arises as to whether science can detect the watering of rich milk down so that it will contain an average amount of fat. In other words, can milk having 5 per cent of fat be watered so that it will have 3.70 per cent, the legal amount, without violating any law or without danger of detection? No. The statute prohibits all adulterations, and this form of adulteration can be detected.

A milk of rich quality would have, in 100 pounds, fat, 5 pounds, solids, not fat, 9.6 pounds, total, 14.6 pounds. Now, suppose we add to that one-fourth in water, the solids not fat would be diluted in the same proportion as the fat, and 100 pounds of this watered mixture would have fat, 4 pounds, solids, not fat, 7.68 pounds, total, 11.68 pounds.

The following shows in convenient form for comparison the three conditions in this case: —

	Natural Milk with 5 Per Cent Fat.	The same Watered one-fourth.	Natural Milk with 4 Per Cent Fat.
Fat, ...	5.00	4.00	4.00
Solids not fat, ...	9.60	7.68	9.40
Total, ...	14.60	11.68	13.40

In watering this milk the fat and the solids not fat are diluted or reduced in the same proportion, in the above illustration one-fifth.

Ordinary milk with 4 per cent of fat should have over 9 per cent of solids not fat, and the discrepancy between 9.40 and 7.68 tells the watery story.

The chemist whose analysis reached such results as fat, 4, solids not fat, 7.68, total, 11.68, would have no hesitation in making oath that the milk was absolutely watered.

The Dairy Bureau recently secured the conviction of a person for selling two samples of milk which tested as follows: —

	No. 1.	No. 2.
Fat,	1.66	2.22
Solids not fat,	8.66	8.38
Total,	10.32	10.60

These were suspicious samples, and the chemist felt that there was a strong probability that the milk had been artificially watered. The producer of the milk, however, testified under oath that the milk had been under his control and supervision every moment from the time it was drawn from the cow — a Holstein — until the detective officer took the sample, and that no water had been added to what the cow put in it naturally. This did not save him from being adjudged guilty, because it is against the law to sell milk of less than average quality even if it is honest (?) milk.

For the purpose of enforcing the law, milk that has been artificially watered from the pump or faucet, and that which has been naturally watered more than the average, are treated alike; but there is a possibility that the above producer told the truth, and that the milk alluded to may have been free from artificial watering, because the solids not fat are considerably over 8 per cent.

In contrast with this was a case which the board of health had last year. It attracted considerable attention and sym-

pathy in the town where the case was tried on account of the high standing of the farmer. The milk which he sold analyzed as follows : —

	No. 3.	No. 4.	No. 5.
Fat,	4.00	3.30	3.60
Solids not fat,	7.94	7.74	7.68
Total,	11.94	11.04	11.28

Although these three samples analyzed higher than the Nos. 1 and 2, alluded to above, the figures tell a more emphatic and unquestionable story of adulteration, because in each of these three latter samples the solids not fat are less than 8 per cent, which indicates very clearly that the milk was watered, especially when such low figures are associated with such amounts of fat as 4 and 3.6 per cent.

Last summer the Dairy Bureau secured the conviction of a restaurant keeper at Revere Beach for selling milk which tested : —

	No. 6.
Fat,	2.20
Solids not fat,	7.20
Total,	9.40

In this case the fat was substantially the same as in No. 2 above, but here the amount of solids not fat is as low as 7.20, while those in No. 2 were 8.38. This low amount of solids not fat establishes beyond any reasonable doubt the fact that this last sample (No. 6) was watered with malice aforethought. And though the attorney plead with the judge to place the case on file in consideration of the good reputation of his client, the evidence of the chemist was that a moral as well as a statutory offence had been committed, and this led the judge to impose the usual fine.

The purchaser of milk who has only the Babcock test cannot detect adulterated milk where the fat is of satisfactory quantity; nothing will do that but a complete analysis, which discloses the ratio between the fat and the solids not fat; but where the purchaser suspects any trouble of this kind the use of the lactometer, which gives the specific gravity, will be of assistance. Normal milk should have a specific gravity of about 1.032; watered milk would be less.

The principles explained above illustrate the dangerous competition to which honest farmers have to submit when whole milk is adulterated with skim-milk. We detect added water by a reduction in the solids not fat; but when skim-milk is added to whole milk the amount of solids not fat remains without much change. A milk containing 4 per cent or above of fat can receive a small admixture of skim-milk and the detection would be very difficult. We allude to this because there is strong suspicion in the minds of many that some of the large surplus of sale milk in Boston is due to the extending of whole milk with skim-milk. Every can of skim-milk which is used in this way creates a surplus of one can of whole milk, for which farmers get only the butter value. The milk contractors can hardly refuse to sell skim-milk to those who apply for it, with the plausible story of having to supply a baker or something of that kind. Unquestionably there is considerable food value in skim-milk of which the public would be deprived were this by-product to be excluded from the market, but we are sometimes inclined to believe that the injury caused by the fraudulent use of skim-milk is greater than the benefit which the public receives from the food value which there is in the skim-milk that finds its way to market.

Milk is sometimes tampered with by dishonest employees, who remove the top of a can after it has stood for some time, and then fill the can with water. Unquestionably some honest farmers have been prosecuted for such delinquencies of employees, in accordance with the well-recognized rule to which business men of every kind are subjected, that the principal is responsible for the acts of his agent. Where a farmer makes a careful study, by the

aid of the Babcock tester, of the quality of the milk he produces, if it is not satisfactory on reaching the city, he has a clue on which to work in detecting possible dishonesty of carriers or others.

The chemist will often be very conservative in stating positively that a sample of low-grade milk owes its poverty to "topping" and watering, because the variation in the proportions of fat and solids not fat is less than when a larger quantity of water has been added to milk. Still, when we find milk with an amount of fat less than might be expected from the solids not fat, particularly if the solids not fat are slightly below the normal, we have grounds for strong suspicions that the milk has been tampered with in this way. In the case of sample No. 1, above, in which the fat was 1.66 per cent and the solids not fat 8.66 per cent, while there is a possibility that it might have been as the producer testified under oath, there are also reasonable grounds for strong suspicions that part of the fat had been removed and a small quantity of water added.

In this brief paper we have not attempted to discuss the composition of milk exhaustively, but to present so much of the subject of milk, and of the ways in which milk is adulterated, as to help farmers who are selling milk to conduct their business more intelligently, by the help of the Babcock tester. With this they can always be on the safe side as to the quality of their product. Understanding the significance of the fat test, they can keep posted as to the quality of the product they are selling.

Concentrated Feed Stuffs.

BY J. B. LINDSEY, PH.D., DEPARTMENT OF FOODS AND FEEDING, HATCH EXPERIMENT STATION.

The term "concentrated feed," taken in its broadest sense, is meant to include the grains and other seeds of agricultural plants, as well as their manifold by-products left behind in the process of oil extraction and in the preparation of human foods.

All cattle feeds, either concentrated or coarse, are made up of six groups of substances: Water, ash, cellulose or fibre, fat, protein and non-nitrogenous extract matter.

Water. — The several grains and by-products contain when placed upon the market from 8 to 15 per cent of water.

Crude Ash represents the mineral ingredients of the seed. It will remain behind as ashes should the seed be burned. These ashes consist of lime, potash, soda, magnesia, iron, phosphoric acid and sulphuric acid.

Crude Cellulose or Fibre is the coarse or woody part of the plant. It may be called the plant's framework. It is present as a rule only to a limited extent in the grains and by-products.

Crude Fat includes not only the various fats and oils found in different feed stuffs, but also waxes, resins and coloring matters. It is sometimes termed ether-extract, because it represents that portion of the plant soluble in ether. Fat found in grains and seeds is comparatively free from foreign substances (waxes, resins, etc.)

Crude Protein is the general name for all of the nitrogenous matters of the seed. It corresponds to the lean meat in the animal, and may be termed "vegetable meat." It has the same elementary composition as animal flesh, and

is considered the most valuable part of the concentrated feeds.

Non-nitrogenous Extract Matter consists of sugars, starch and gums. The grains are very rich in starch and similar substances.

Carbohydrates. — The fibre and extract matter have the same functions in the process of nutrition, and collectively they are termed carbohydrates.

Nutritive Ratio. — The numerical relation which the protein of a feed bears to the carbohydrates (and fat reduced to carbohydrates) is termed its nutritive ratio. Fat is multiplied by 2½ to convert it into carbohydrates. If a ton of feed should contain 96 pounds of digestible protein, and 928 pounds of digestible carbohydrates, it would have 9.4 times as much carbohydrates as protein or 1 : 9.4, which is its nutritive ratio.

Digestibility. — Any feed-stuff is valuable as a source of nourishment only so far as its various parts can be digested and assimilated. That the concentrated feeds are much more digestible than the coarse fodders may be shown from the following table : —

TABLE I.

	100 POUNDS TIMOTHY HAY CONTAINS :			100 POUNDS COTTON-SEED MEAL CONTAINS :		
	Composition.	Per Cent Digestible.	Pounds Digestible.	Composition.	Per Cent Digestible.	Pounds Digestible.
Water,	15.0	-	-	8.0	-	-
Crude ash,	4.3	-	-	6.9	-	-
Crude fibre,	28.4	58	16.47	6.8	32	2.2
Crude fat,	2.4	61	1.46	10.7	93	10.0
Crude protein,	6.3	48	3.02	41.6	88	36.6
Extract matter,	43.60	63	27.46	26.0	64	16.5
Total,	100.00	-	48.41	100.00	-	65.3

The timothy hay has but 48.41 pounds of digestible matter, while the cotton-seed has 65.3 pounds.

In addition to their increased digestibility the concentrated feeds as a rule possess a much higher protein content

than the coarse fodders. The above table shows the extremes, the timothy having 3.02 pounds and the cotton-seed 36.6 pounds in 100.

I. — CLASSIFICATION OF THE CONCENTRATED FEEDS.

TABLE II.

Division I.	Division II.
Medium to high in protein. Medium in carbohydrates. 75 to 85 per cent digestible.	*Low in protein. High in carbohydrates.* 75 to 85 per cent digestible.
Cotton and linseed meals, gluten meal, pea and bean meals, peanut meal, gluten feeds, corn oil cake, Atlas meal, Chicago maize feed, Hall's dairy feed, dried brewers' grain, malt sprouts,* bran and middlings,* Boston and Quincy mixed feeds.*	Wheat, oats, barley, rye, Indian corn, corn and cob meal, corn-germ feed, hominy feed or chop, cerealine feed, rice meal, oat feeds.*

Below 12 per cent may be termed *low protein*, from 12 to 23 per cent medium protein, and above 23 per cent high protein. Below 50 per cent may be termed low carbohydrates, between 50 and 60 medium, and from 60 to 75 per cent high carbohydrates. All of the feeds in Division I. have a narrow nutritive ratio (1 : 2 to 1 : 5), and those in Division II. a wide ratio (1 : 8 to 1 : 10).

II. — PREPARATION, COMPOSITION AND DIGESTIBILITY OF CONCENTRATED FEEDS.

DIVISION I.

Cotton-seed Meal. — The seeds of the cotton plant are black in color, irregular egg-shaped in form, and almost hidden by a tuft of white fibre which covers their surface. The meat of the seed is covered with a thick, tough hull. Machines have been invented to remove this hull, and the meat is subjected to warm pressure which removes the greater part of the oil. The pressed cake is ground, and results in the decorticated, bright yellow cotton-seed meal of commerce. Sometimes a considerable portion of the hull is ground with the meat, making a dark meal of inferior feeding value.

Linseed Meals. — The seeds of the flax are flattened elliptical oval, pointed at the lower end, and of a brown

* From 60 to 70 per cent digestible.

color. The seed in its natural state contains 30 to 35 per cent of oil. Twenty to 28 per cent of the oil of the seed can be removed by warm pressure. The pressed cake, dried and ground, furnishes the old process linseed meal. Some factories secure a more thorough removal of the oil by the use of naphtha or other solvent. The naphtha is removed by steam, and the dried material furnishes what has been known as the new process linseed meal. Flax meal is the particular name of new process meal put out by a single firm. Linseed meal is a very valuable and safe feed. The brand or brands highest in protein and lowest in fat are to be preferred. Linseed meals are generally known as oil meal. This is an incorrect name, the oil in many cases being very thoroughly removed.

Pea and bean meals are high in protein and fat. Peanut meal is very high in protein. They are all valuable feed stuffs, and quite generally used in European countries.

TABLE III.

Average Composition.

[Figures equal percentages or pounds per hundred.]

	Number of Analyses.	Water.	Ash.	Fibre.	Fat.	Protein.	Extract.	Pounds Digestible in 100.
Prime cotton-seed meal,	32	8.00	6.90	6.84	10.74	41.62	25.90	65.3
Poor quality cotton-seed meal,	*	10.60	7.20	24.90	6.60	24.70	26.00	41.6
New process linseed meal,	8	8.30	5.90	8.50	2.90	36.10	37.30	71.8
Flax meal,	1	9.85	5.26	7.62	2.47	40.16	34.64	71.3
Old process linseed meal,	8	9.70	6.20	7.80	6.60	33.10	36.60	68.4
Peanut meal,	*	11.50	4.90	5.20	7.30	47.00	24.10	70.4

Gluten Products.

The various products known as gluten meals, gluten feeds, germ feed and the like, are the residues resulting from the manufacture of starch and glucose (grape sugar) from maize or Indian corn.

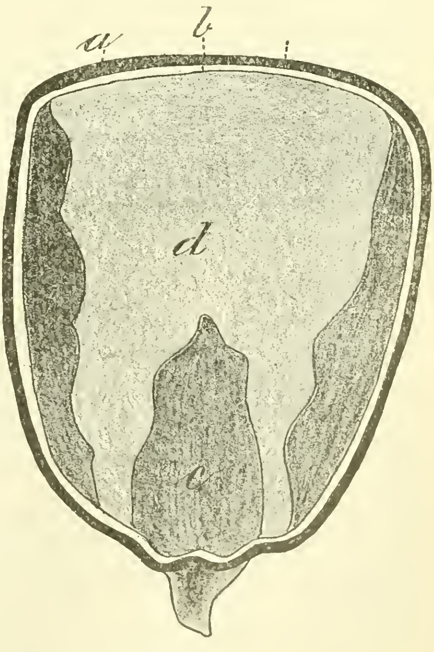
The average of a large number of analyses of water-free Indian corn shows it to have the following composition : —

* Number not known.

Crude ash,	1.7 per cent
Crude fibre,	2.5 per cent
Crude fat,	5.4 per cent.
Crude protein,	11.5 per cent.
Extract matter (chiefly starch),	78.9 per cent

It is quite evident that the corn is made up chiefly of starchy matters. The removal of the larger part of the starch naturally increases the proportion of the other ingredients. The constituent contained in the corn next in amount to starch is the protein, — a general name for all albuminoids. In case of the corn it is called gluten, and after the removal of the starch, this being by far the most prominent constituent remaining, the feeds have been termed gluten feeds. Even in the best methods of manufacture, the starch is not all removed, the residues being often made up of one-half of starchy matter.

Parts of Indian Corn. — The accompanying enlarged cut * of a corn or maize kernel will assist in locating the four distinct parts which are of interest in this study.



a is the husk or skin covering the whole kernel; it consists of two distinct layers, the outer and inner, which when removed constitute the bran and contain practically all of the crude fibre of the whole grain.

b is a layer of gluten cells which lie immediately underneath the husk; it is, as a rule, yellow in color and cannot be readily separated from the remainder of the kernel. This part is the richest of any in gluten.

* This cut was kindly loaned by Director E. B. Voorhees of the N. J. Station. The description of the same is taken from Bulletin 105 of the N. J. Station.

c is the germ, which is readily distinguished by its position and form; it also contains gluten, though it is particularly rich in oil and mineral constituents.

The large portion (*d*) is composed chiefly of starch; the dark color indicates the flinty part in which the starch-holding cells are most closely compacted.

How the Parts are separated.† — The corn is first soaked in warm water for many hours, until swollen and thoroughly softened. It is then run through stones set quite a distance apart. This rubs off the husk and the germ, and at the same time beats up the starch and the gluten. The mass is then sifted through fine sieves, the starch and gluten passing through, the husk and germ remaining behind to be separated, if desired, by gravity, the husks floating and the germs sinking in the water. The starch and gluten which have passed through the sieves are separated by running into large tanks and settling, or by slowly running through long troughs. The starch being heavier settles to the bottom, while the lighter yellow gluten-containing material runs off from the top.

The by-product in this manufacture may either consist of one product, being a mixture of hulls, germ and gluten, or of three, when the hulls, germ and gluten are separated. The various gluten products are, however, all parts of the Indian corn, though they differ somewhat in color and general appearance.

Gluten Meal.

This product is generally composed of the gluten of the corn, the hull and germ having been separated. In some brands of gluten, the germ is evidently ground with the gluten, giving a product higher in fat. Here follows a table showing the average composition of the different brands of gluten meal: —

† Taken from Bulletin No. 48, Vermont Experiment Station.

TABLE IV.

[Figures equal percentages or pounds per hundred.]

BRANDS.	Number of Analyses.	Water.	Ash.	Fibre.	Fat.	Protein.	Extract.	Pounds Digestible.
Chicago gluten meal (old process),	3	9.2	.8	1.1	6.2	30.4	52.2	81 3
Chicago gluten meal (new process), Manufactured by Chicago Sugar Refining Co., Chicago, Ill.	4	9.6	1.3	2.4	6.0	38.4	42.3	*
Cream gluten meal, Chas. Pope Glucose Co , Chicago, Ill.	1	9.0	.6	1.7	7.6	36.6	44.5	79.4
King gluten meal, National Starch Manufacturing Co., New York.	2	7.2	1.7	1.4	19.1	34.6	35.9	80.1
Iowa golden gluten, Firmenish Manufacturing Co., Marshalltown, Ia.	2	9.0	1.1	6.6	13.3	25.5	44.5	†
Hammond gluten, Stein, Hirsh & Co., Chicago, Ill.	1	8.2	1.1	1.5	9.7	29.9	49.6	†

The new process Chicago gluten is superior to that formerly sold, because it contains a noticeably higher percentage of protein. This is due to a more thorough removal of the starch, and possibly to a saving in gluten formerly lost in the manufacturing process. The Cream gluten closely resembles the Chicago. The King gluten meal contains a high percentage of fat.

The Golden gluten contains considerable hull, and probably the germ, ground with the gluten, which results in a lower protein percentage.

Hammond gluten meal resembles the old process Chicago.

Gluten meals containing low percentages of fat are safer to feed than those containing high percentages. Excess of fat tends to produce inflammation of the milk glands (*garget*).

All of the gluten meals, Iowa excepted, are very low in fibre ; these products are classed with the cotton and linseed meals as the most concentrated feed stuffs. They are heavy, and when fed in any quantity should be mixed with some lighter material, such as bran.

* Probably about the same as old process. † Not determined.

Gluten Feeds.

The gluten feeds consist of the hull, germ and gluten of the corn mixed and coarsely ground together. They contain more fibre and fat and less protein than the gluten meals. They are more bulky and are safer to feed by themselves than the gluten meals.

Table V.

Average Composition of Gluten Feeds.

[Figures equal percentages or pounds per hundred.]

BRANDS.	Number of Analyses.	Water.	Ash.	Fibre.	Fat.	Protein.	Extract.	Pounds Digestible.
Buffalo gluten feed (old process),	15	8.1	.9	6.8	11.9	23.0	49.3	
Buffalo gluten feed (improved process), American Glucose Co., Peoria, Ill.	1	10.4	2.6	6.7	4.4	27.1	48.8	
Peoria gluten feed, Peoria Grape Sugar Co., Peoria, Ill.	4	7.2	1.2	7.6	12.4	20.5	51.1	
Diamond gluten feed, Rockford Sugar Refining Co., Rockford, Ill.	1	8.4	1.1	7.3	10.2	22.0	51.0	77
Chicago maize feed, Chicago Sugar Refining Co., Chicago, Ill.	5	8.2	.6	7.5	7.1	24.9	51.7	
Atlas gluten, Atlas Distilling Co., Peoria, Ill.	7	7.4	1.7	11.0	12.4	30.3	37.2	70
Dried brewers' grain (high protein),	2	7.5	2.9	12.3	6.5	31.4	39.4	62
Dried brewers' grain (low protein),	4	9.9	4.1	10.2	4.4	21.0	50.4	66

The improved Buffalo gluten feed is said to be produced by increasing the percentage of ash, the recovery and addition of some of the gluten formerly lost, and in the extraction of the fat. The one analysis of improved feed given above bears out this statement. The Chicago maize feed has less fat and rather more protein than the ordinary gluten feeds.

Atlas Gluten Meal,* so called (better gluten feed), is quite different from the regular glutens. It is the by-product resulting from the manufacture of liquor from the various grains. The process consists practically in the re-

* Atlas feed and brewers' grain are not corn by-products. They consist of hulls, germ and gluten of different grains, and the process of preparation is different from the regular gluten feeds. It is thought best, however, to speak of them at this time.

moval of a considerable portion of the starch by fermentation. The residue is kiln-dried and consists of the hulls, gluten, germ and part of the starch. It has a slightly acid smell and taste. The uncertainty in its composition detracts from its value. Analyses have shown it to be equal to, and in some cases superior to gluten feeds.

Dried Brewers' Grain * is the residue from beer manufacture. It consists of some of the starch, together with the hulls, germ and gluten of the barley. A small portion of the gluten and the larger part of the starch have been removed by extraction and fermentation. It varies considerably in composition and has been designated as high and low in protein.

Miscellaneous Feeds. (Division I.)

Wheat Bran and Middlings. — Wheat has the same general formation as the corn kernel. The bran is the exterior covering of the wheat, and is removed by machinery in the process of flour manufacture. Middlings is the layer below the bran, and contains more starchy matter and less fibre. These feed stuffs vary more or less in quality, depending upon the quality of the wheat, process of flour manufacture, etc. Careful analyses and digestion tests made at the experiment station have failed to note any material difference in the feeding value of selected spring and winter wheat bran.

Boston and Quincy Mixed Feeds. — These have also been termed heavy brans. They are mixtures of bran and cheap flour. Analyses thus far made indicate that they would prove slightly superior in feeding value to bran alone. Mixed feeds are of very uncertain composition, however.

Hall's Dairy Feed. — This is said to be a mixture of cotton-seed meal, gluten meal, bran, corn meal and ground oats. It resembles the gluten feeds in composition.

Malt Sprouts. — Malt used in beer manufacture is prepared by moistening barley and allowing it to sprout. The sprouting produces a ferment called diastase, which changes

* Atlas feed and brewers' grain are not corn by-products. They consist of hulls, germ and gluten of different grains, and the process of preparation is different from the regular gluten feeds. It is thought best, however, to speak of them at this time.

starch into sugar. After the formation of the diastase, which requires a certain number of days, the barley is dried, and the sprouts removed by machinery and sold for cattle feed. The barley is now termed malt.

TABLE VI.

Average Composition of Miscellaneous Feeds.

[Figures equal percentages or pounds per hundred.]

	Number of Analyses.	Water.	Ash.	Fibre.	Fat.	Protein.	Extract.	Pounds Digestible.
Wheat bran, ...	49	10.6	6.8	9.8	4.5	16.1	52.2	60
Wheat middlings, ...	9	10.3	5.1	6.8	4.8	15.7	57.3	70
Boston mixed feed, ...	2	10.9	4.0	5.7	4.5	17.1	57.8	?
Quincy mixed feed, ...	1	9.7	5.4	7.1	4.6	16.7	56.5	?
Hall's dairy feed, ...	1	7.0	6.2	10.2	9.4	20.8	46.4	?
Malt sprouts, ...	5	9.6	5.9	11.0	1.7	24.8	47.0	58

DIVISION II.

Wheat, Barley, Oats, Rye and Indian Corn. — But very little need be said relative to the grains. They are concentrated feeds from which many of the concentrated by-products are derived. They are all very rich in starchy material and poor in protein and fibre.* Wheat, oats and barley contain as a rule 1 to 2 per cent more protein than corn and rye. Different varieties vary more or less in quality within narrow limits. Climatic conditions and fertility of soil also exert a very noticeable influence on the quality of the grains.

* Except oats, which contain 9 to 10 per cent of fibre.

TABLE VII.

Average Composition of the Grains.

[Figures equal percentages or pounds per hundred.]

	Water.	Ash.	Fibre.	Fat.	Protein.	Extract.	Pounds Digestible.
Wheat,	14.00	1.72	1.72	1.98	11.41	69.17	73
Barley,	14.00	2.32	2.58	1.72	11.95	67.43	73
Oats,	14.00	2.92	9.29	4.82	11.35	57.62	58.5
Rye,	14.00	1.81	1.63	1.63	10.33	70.60	?
Corn,	14.00	1.40	1.80	3.80	9.50	69.50	73.7
Corn and cob meal,	14.00	1.34	6.40	3.50	8.69	66.00	68.5

Corn Germ Feed. — This consists of the hulls and germ of the corn, coarsely ground. It is a by-product from glucose manufacture, but is classified here because of its low protein content. But very little is sold in Massachusetts at present.

Cerealine Feed. — This feed comprises the hull, bran, germ and some of the starch of the corn. It is the by-product resulting in the manufacture of the breakfast preparation known as cerealine. It is very coarse. In chemical composition it resembles corn meal. While no feeding tests are on record, it can be assumed to have a nutritive value similar or slightly inferior to corn meal.

Hominy Feed or Chop. — This is the by-product from the preparation of hominy from corn. It consists essentially of the same materials as cerealine, which it resembles very closely in composition. It is quite finely ground. The separation of hull, bran and germ is said to be brought about solely by the aid of machinery and steam.

Rice Meal. — In preparing rice for human consumption, various mechanical processes are employed. After the hull is removed, the rice is brought into mortars holding from four to six bushels each, and pounded, to remove the yellow gluey covering of the grain and give it the creamy color so much desired. This pounding really removes the chaff and some of the flour, and leaves the grain

but little broken. The rice is then polished to give it a pearly lustre, which is effected by friction of the grains of rice against tanned moose hide. That portion rubbed off is termed rice polish. The chaff and flour above referred to, and in some cases the polish also, are mixed and sold as rice meal for cattle feeding. It is much used and highly prized in Europe, and small quantities are sometimes placed on our Massachusetts markets. It resembles corn meal in composition and feeding value.

Oat Feed, Corn and Oat Chop, etc. — Oat feed is the refuse from factories engaged in the preparation of oatmeal for human food. It consists of poor oats, oat hulls and some of the bran and starch which are removed in the process of manufacture. In some cases it is mixed with corn, as corn and oat chop. While it has the same type of composition as corn meal, it varies much in the quantity of hulls it contains, and consequently in feeding value.

TABLE VIII.

Average Composition.

[Figures equal percentages or pounds per hundred.]

	Number of Analyses.	Water.	Ash.	Fibre.	Fat.	Protein.	Extract.	Pounds Digestible.
Corn germ feed,	9	7.35	1.08	10.85	10.80	11.27	58.65	?
Hominy feed (all analyses),	12	11.10	2.50	3.80	8.30	9.80	64.50	?
Hominy feed (recent analysis),	1	7.77	2.88	4.27	9.76	11.75	63.57	?
Cerealine feed,	2	9.91	2.63	5.32	8.86	12.11	61.17	?
Rice meal,	1	10.00	8.40	5.63	13.17	11.59	51.21	66
Oat feed,	10	7.50	4.90	13.00	4.30	11.80	58.50	?

Excepting rice meal, the digestibility of the above feeds has not been determined, but it is probably slightly below corn meal. Oat feed would frequently show a decidedly inferior digestibility.

III. HOW BEST TO UTILIZE THE CONCENTRATED FEEDS.

Attention has already been called to the fact that such feeds are especially valuable because of their digestibility and high protein content. Home-grown coarse feeds on the contrary are of a starchy nature, and much less digestible. Now many experiments have shown that milch cows of 1,000 pounds live weight need the following quantities of digestible nutrients daily: Protein, 2.5 pounds; fat, .5 pound; carbohydrates, 13.0 pounds; total, 16.0 pounds; nutritive ratio, 1 : 5.4 pounds. Such a ration contains 16 pounds of total nutrients and about 5½ times as much carbohydrates as protein, and it is said to be properly balanced. Now, if a cow should be fed all she would consume of any palatable, dry, coarse fodder, such as an average quality of hay, she would have at her disposal the following digestible constituents: Protein, 1.4 pounds; fat, 0.4 pound; carbohydrates, 12.4 pounds; total, 14.2 pounds; nutritive ratio, 1 : 9.5 pounds. Such a ration lacks in protein as well as in total digestible matter. It has 9.5 times as much carbohydrates as protein, and is said to be improperly balanced. It is in order to increase the protein and the total digestible matter, that recourse is had to the concentrated feeds. By the proper combination of these feeds, fed in approximately definite quantities daily, these ends can be attained. Here follows the *detailed* classification of the concentrated feeds made on the basis of the protein they contain: —

TABLE IX.

Division I.			Division II.
Class I.	Class II.	Class III.	Class IV.
Cotton-seed meal, peanut meal, linseed meals, Chicago cream and King gluten meals, Golden and Hammond gluten meals.	Atlas meal (feed), gluten and maize feeds made from corn, dried brewers' grain.	Wheat bran and middlings, malt sprouts.	Wheat, barley, corn, rye, oats, corn germ feed, cereline, hominy and oat feeds.

The feeds in Class I. furnish the largest amount of protein, those in Class II. next largest, and so on. Those

standing first in their class are richest in protein, and those last poorest. For practical purposes, in combining the various concentrated feeds into rations, the feeds in each class may be regarded as having approximately equal feeding values, the market price governing the selection. Other things being equal, those standing first in their class are to be preferred (see comparative analyses of different feeds). The feeds in Class IV. are valued chiefly because they furnish a large amount of very digestible, starchy feed, and not because of their high protein content.

Concentrated grain mixtures for milch cows of 1,000 pounds live weight, to be fed with coarse feeds such as hays, straws, corn stover, corn ensilage, etc.: —

I.	II.	III.	IV.
100 pounds, Class I.	100 pounds, Class I.	100 pounds, Class I.	100 pounds, Class I.
100 pounds, Class II.	100 pounds, Class II.	100 pounds, Class IV.	150 pounds, Class III.
100 pounds, Class IV.	100 pounds, Class III.	Mix and feed 5 to 7 quarts daily.*	Mix and feed 6 to 8 quarts daily.
Mix and feed 5 to 7 quarts daily.*	Mix and feed 7 to 9 quarts daily.		

By 100 pounds, Class I., etc., is meant the particular feed selected in the class, and not all enumerated under the class.

The mixtures are intended to be fed in connection with any coarse fodder combination. They are also suitable for growing neat stock, the quantity fed daily to be governed by the size of the animal. For fattening cattle, two-thirds of the mixture should consist of one of the feeds in Class IV., and one-third from Class II. or III.

In case a grain mixture is composed of three concentrated feeds, see during the winter that not more than two of the feeds have a high fat percentage and in summer not more than one. In case two feeds only are employed in the mixture, but one of them should have a high fat percentage, especially in summer. Those feeds especially rich in fat are cotton-seed meal, King gluten meal, Atlas gluten meal

* If cerealine, hominy or corn germ feed is selected from Class IV., feed 7 to 9 quarts daily.

and the gluten feeds. Excess of fat, in summer especially, is very liable to produce inflammation of the udder.

The lesser amount of grain as specified above, fed together with the coarse feeds, will furnish about two pounds of digestible protein daily, and the larger amount two and one-half pounds. When cows derive part of their feed during the summer from pasture grass, and part from soiling crops, about one-half the quantity of the grain mixtures can often be fed to advantage. In case the soiling crops are made up of one-half leguminous fodder, no grain need be given. Should corn and soja bean ensilage or millet and bean ensilage be fed in place of clear corn ensilage, the grain ration can be reduced about one-third.

As the cow approaches the time of calving the grain ration can be gradually reduced. The cow ought to go dry from 45 to 60 days.

TABLE X.

Showing the Comparative Commercial Values of the Different Feeds.

	Per Ton.	Per Ton.
Wheat bran,	$18 00	$14 00
Corn, wheat and barley meals,	19 00	15 00
Oat meal,	17 00	13 00
Hominy and cerealine feeds,	18 00	14 00
Oat feed,	16 00	12 50
Rice meal,	21 00	16 00
Wheat middlings,	21 00	16 00
Brewers' grains,	21 00	16 00
Malt sprouts,	23 00	18 00
Gluten and maize feeds,	28 00	22 00
Atlas meal (feed),	28 00	22 00
O. P. linseed meals,	31 00	24 00
N. P. linseed meals,	32 50	25 00
Gluten meal (first grade),	35 00	27 00
Gluten meal (second grade),	31 00	24 00
Cotton-seed meal,	35 00	27 00

The *comparative* dollars and cents values of the feeds as given in the above table *do not* express their specific physiological effects in the process of nutrition. The figures are

intended to show *comparative* and not actual commercial values. They are obtained by figuring the digestible protein, fat and carbohydrates at similar prices per pound. The table shows that when wheat bran sells for $18 per ton in the market, corn meal should be worth $19, wheat middlings $21, brewers' grains $21, etc. Again, should wheat bran sell for $14, corn meal would be worth $15, middlings $16, etc. The prices of themselves have nothing to do with suitable concentrated feed combinations, but are to be used as economic guides in purchasing. Thus, should corn meal sell at $23 per ton, and gluten feed at $21 per ton, it would not, for economical reasons, be advisable to use grain mixtures containing corn meal.

IV. FERTILIZING VALUE OF CONCENTRATED FEEDS.

Aside from their direct feeding effects, all feed stuffs have a distinct fertilizing value. This value depends chiefly on the amount of nitrogen (protein = nitrogen multiplied by 6.25) they contain, those that are highest in that ingredient being most valuable. Some feed stuffs, such as cotton and linseed meals, bran and brewers' grain, contain considerable quantities of phosphoric acid and potash.

TABLE XI.

Showing Approximate Pounds and Value of Nitrogen, Phosphoric Acid and Potash in One Ton; also Comparative Fertilizing Value, 1 being Poorest.

DIVISION I.

	Nitrogen.	Phosphoric Acid.	Potash.	Money Value.	Comparative Values.
Cotton-seed meal,	134	50	36	$20 13	3.7
Linseed meals,	115	34	25	16 58	3.0
Chicago, cream and King gluten meals,	120	8	traces	14 76	2.7
Iowa and Hammond glutens,	88	8	traces	10 92	2.0
Gluten and maize feeds,	75	8	traces	9 36	1.7
Atlas meal,	96	5	3	11 89	2.2
Dry brewers' grain,	70-100	20	traces	11 10	2.0
Wheat bran,	50	42	28	9 29	1.7
Malt sprouts,	78	32	34	12 50	2.3

DIVISION II.

Grains, hominy, cerealine and oat feeds,	36	14	10	$5 50	1

The preceding table shows that cotton, linseed and gluten meals possess the highest fertilizing value, and that they contain from 2 to 3.7 times as much value in fertility as do the grains and allied products. Such feeds, therefore, when fed to animals, produce a rich manure.

The concentrated feeds, being easy to handle, can be applied directly to the land, and as good results obtained as from various forms of commercial fertilizing material of a similar nature. When the concentrated feeds are first fed to farm animals, from 80 to 90 per cent of the fertilizing value of the feeds reappears in the manure, providing the latter is carefully preserved. The same amount of plant food as it exists in animal excrement is by no means as valuable, from a commercial standpoint, as a like amount in the form of concentrated feed, for the very reason that it costs so much more to handle it. It is as a rule, nevertheless, considered better economy in a system of mixed farming, to first secure the feeding effects of the feeds, and then their fertilizing value in the manure.

V. IS THERE NEED OF A LAW TO CONTROL THE SALE OF CONCENTRATED FEED STUFFS?

I think this question can be answered very decidedly in the affirmative, and I desire to state the reasons why.

Every purchaser of concentrated stuffs realizes the great variety of such substances that are offered for sale, and the immense quantities that are being yearly consumed by our Massachusetts farmers. Those enumerated in the preceding pages are the most important ones now in our markets. Scarcely a year passes but that several new articles, generally by-products from different industries, of uncertain composition, find their way into the trade. Now while these substances contain some of each of the several groups of feed constituents — protein, fat and carbohydrates — they are purchased chiefly for the protein they contain. The fodder crops grown by the farmer are nearly all rich in starchy materials, and he has recourse to these by-products to supplement his home-grown starchy feeds, in order to produce well-balanced fodder rations for his cattle. These

various by-products contain from 10 to 45 per cent of protein, as well as from 3 to 20 per cent of fat. Now an excess of fat in a concentrated feed is objectionable, because of its liability to produce inflammation of the udder (*garget*). A feed stuff containing from 7 to 9 per cent can be fed with a greater degree of safety. An excess of by-products high in fat and protein, fed to animals, is sure to cause trouble. It is, therefore, very important that the farmer should have the privilege of knowing the amount of the important constituents contained in the feed he is purchasing, and it is only fair play for the manufacturer to state *the quality* of the goods he offers for sale.

Again *it is a fact that the larger number of these individual brands of feed stuffs vary, from time to time, very seriously in composition*. This I desire to prove from actual analyses made at the Massachusetts Experiment Station within the last two years.

Cotton-seed Meal.

	Prime Quality.	Poor Quality.*						
	Average 32 Analyses.	I.	II.	III.	IV.	V.	VI.	VII.
Water, . . .	8.00	8.00	8.00	†	†	10.00	†	8.00
Crude fat, . .	10.74	†	†	†	†	†	†	6.69
Crude protein, .	41.62	12.81	21.75	22.88	23.40	26.56	30.62	32.34

These poor quality meals were quite dark in color and contained the hulls ground with the meat. They were usually offered at from one to two dollars less per ton than prime meal, on the ground that they were a little "off color." The larger part of them were really not worth much over one-half as much as prime meal.

Gluten Meals.

The *better class* of gluten meals has been fairly even in composition of late. At least one manufacturer prints the guaranteed composition on the bags. Such an article is of extra quality, and the manufacturer is desirous of stating

* All analyses made in 1896. † Not determined.

the fact. There have been many gluten meals tested at the experiment station, however, varying from 25 to 32 per cent in protein, while a high-grade meal will contain from 35 to 38 per cent. Here follow the extremes of 38 analyses of gluten meals : —

	Protein.	Fat.
Highest, ...	39.3 per cent.	21.44 per cent.
Lowest, ...	25.7 per cent.	3.92 per cent.

Gluten Feeds.

The tendency of one or two of the well-known brands of gluten feeds is to remain fairly steady in composition. We find, however, variations of from 8 to 13 per cent in the fat, and from 15.3 to 23.1 per cent in the protein.

	I.	II.	III.	IV.	V.	VI.	VII.
Water (per cent), ...	9.00	8.00	9.00	8.00	7.00	8.00	8.00
Crude fat (per cent), . . .	11.55	8.10	13.50	12.50	13.30	13.56	13.60
Crude protein (per cent), . .	15.30	18.90	20.10	19.60	21.10	22.26	23.10

Atlas Gluten Meal.

The following variations of this feed stuff have been noted since its appearance in our markets : —

	I.	II.	III.	IV.	V.	VI.
Water (per cent), ...	8.00	7.00	5.00	11.00	9.00	8.00
Crude fat (per cent), ...	10.30	11.50	13.30	13.53	11.92	14.40
Crude protein (per cent), ...	22.60	26.50	31.00	33.20	35.30	37.26

There is a difference of nearly three hundred pounds of protein in one ton, in different samples of this feed; and the farmer is asked to pay the same amount of money per ton in all cases.

Oat Feeds.

	I.	II.	III.	IV.	V.	VI.
Water (per cent),	10.00	6.50	8.00	10.00	7.00	10.00
Crude fat (per cent),	3.02	3.25	3.00	4.23	4.50	3.90
Crude protein (per cent),	8.19	8.75	9.20	10.18	11.10	14.00

Attention is called to the great variation in the percentage of protein present, namely: from 8.2 to 14 per cent. Sample I. would contain 164 pounds, and sample VI. 280 pounds, per ton, a difference of 42 per cent.

Mixed Feeds.

	Boston Mixed Feed.		Quincy Mixed Feed.	Heavy Bran.	
	I.	II.	I.	I.	II.
Water (per cent),	10.00	11.00	10.00	9.00	9.00
Crude fat (per cent),	4.46	5.23	4.58	5.24	3.95
Crude protein (per cent),	15.12	21.60	16.70	15.20	18.20

These mixtures of bran and flour vary from 15.1 to 21.6 per cent of protein.

Dried Brewers' Grain.

	I.	II.	III.	IV.	V.
Water (per cent),	8.00	8.00	8.00	7.00	8.00
Crude fat(per cent),	7.40	5.50	7.80	6.70	6.30
Crude protein (per cent),	14.80	17.20	26.70	29.80	33.00

While this article is not sold in our markets to any extent just at present, samples obtained a year ago showed the above variations.

The figures given, and many more that could be cited were it necessary, prove conclusively that the concentrated feeds vary widely in composition and in consequent feeding value.

Recognizing then, firstly, the large number of concentrated by-products in our Massachusetts markets with very different feeding and commercial values, and secondly, that the large majority of these feeds differ quite widely of themselves in composition, and thirdly, that these feed stuffs are purchased by the farmer primarily for their protein content, it is but fair that the manufacturers should be obliged to state the amounts of the most costly and valuable ingredients (from a feeding stand-point) which they contain. The law should further provide that these feed stuffs be inspected at intervals, to see if they are as represented. The farmers simply ask that the manufacturer state what he sells, and sell what he states. The farmer is willing to pay a fair price for his goods. *He objects, however, most decidedly, to be obliged to part with his hard-earned dollars for materials of variable and consequently uncertain quality. Every advantage is, at present, on the side of the manufacturer. The farmer takes all the chances.*

Prof. C. A. Goessmann, in writing on the same subject, has recently used the following language: —

Names may remain the same, while the composition of the article suffers serious changes, in consequence of changes in the parent industry.

Sales without due responsibility regarding the particular quality of the goods delivered leaves the pecuniary risk involved in the transaction in an objectionable degree on the side of the buyer.

The trade in concentrated feed stuffs is to-day in a similar unsatisfactory condition as was the trade in commercial fertilizers before the introduction of a system of State inspection.

The best interests of both manufacturers and farmers render such changes desirable as will impose mutual and equitable responsibility on all parties interested in the transaction.

The limited margins for profit in every branch of animal industry necessitate a most careful attention to all details of the business.

Report of the Meetings of the Massachusetts Fruit Growers' Association.

BY PROF. S. T. MAYNARD, SECRETARY.

For a great many years the amount of fruit consumed by the people of this State has been steadily increasing, but this increase has come not from our own growers but largely from other States and countries. Of the amount of fruit imported into Massachusetts from other States or countries we have no accurate statistics available at this time, but we learn that the city of Boston alone consumed in a single season nearly 2,000,000 cans of apple, and in the city of Worcester a single dealer handled two carloads of the same product; and almost every town or city in the State consumes more or less of apples in this convenient form, none of which are produced by our own fruit growers.

In every city, town or village, evaporated apples, dried plums, peaches and berries are consumed in more or less large quantities; and canned peaches, cherries, raspberries and strawberries are found on the shelves of almost every grocer and provision dealer in the State. During the summer and fall our markets are flooded with fresh fruits from other States: strawberries from Florida, Georgia, Virginia and New Jersey; peaches from most of the southern States; grapes from the south and west and almost every kind of fruit from the Pacific coast.

No State in the Union, probably, consumes so much fruit per capita as our own; and our fruit growers should make a great effort to secure at least a reasonable share of this immense traffic, and supply more fully than is now done our local markets. In many cases the competition will be between our native and the more tropical fruits and we cannot expect to supply our markets out of the local fruiting

season except possibly with dried or canned goods, but there is no section of the country that can produce better apples, pears, plums, cherries, grapes, blackberries, raspberries, currants and strawberries, and a large proportion of these fruits consumed by our people should be produced by our growers. Of course we cannot put the fruit into the markets as early in the season as that shipped from the South, but we can put it into the hands of the consumer in its season, *in a much better condition;* and if we can keep our markets *fully supplied* with extra choice fruit, either fresh, evaporated or canned, at reasonable prices, we shall cut off, in a large degree, the demand for southern and western and inferior fruit.

It is this situation which led to the formation of the Massachusetts Fruit Growers' Association. The first meeting was held at Worcester, March 20, 1895. At this meeting, a two-days session, sixty-seven members were enrolled. Papers were presented on "The care and cultivation of orchards," by Prof. J. W. Clark of North Hadley; "The preparation and packing of fruits for foreign markets," by Geo. A. Cochrane of Boston; "Grape growing in Massachusetts," by H. A. Cook of Shrewsbury; "Insects and fungous pests and remedies," by Prof. S. T. Maynard of the Massachusetts Agricultural College; and "The preservation of fruit by cold storage," by Dr. Jabez Fisher of Fitchburg. Mr. Cochrane advocated in his lecture the packing of fruit for foreign markets in half-barrel boxes, divided into two compartments, and that the fruit should be graded and wrapped as oranges are.

The Massachusetts Fruit Growers' Association was organized, a constitution adopted, and officers elected as follows: president, James Draper of Worcester; vice-president, Samuel Hartwell of Lincoln; secretary, S. T. Maynard of Amherst; treasurer, E. W. Wood of West Newton; auditor, C. L. Hartshorn of Worcester; with a board of twelve directors.

The second meeting was a field meeting, held on the grounds of the Agricultural College at Amherst, on June 14, 1895, with about forty members present. Professor Maynard explained the location of the many points of in-

terest on the grounds. The strawberry experiment plots, where over one hundred and fifty named varieties were in fruit and about the same number of seedlings were fruiting for the first time, were visited. The varieties were studied and tested, but, as no one could test all, conclusions as to the best necessarily varied. The orchards and vineyards were examined; the latter, containing two hundred varieties of grapes trained to the one-arm renewal system, attracted much attention. The greenhouses, the largest glass structures and containing the most complete and extensive collection of economic and commercial plants to be found connected with any agricultural college in the country, were visited, and the methods of construction, ventilation and heating were especially inspected. The grounds about these buildings, planted with a very large and complete collection of the more choice ornamental trees and shrubs, were also examined. The farm department, including the new and spacious barn, was visited, as was also the experiment station, with its laboratories and experiment plots, after which the meeting adjourned, the members expressing themselves as having passed an unusually pleasant and profitable day.

The first annual meeting of the association was held at the hall of the Worcester Horticultural Society, March 12 and 13, 1896.

Thursday — *Morning Session.*

The meeting was called to order by President Draper, who called on O. B. Hadwen to give the address of welcome. The reports of the secretary, treasurer and auditor were presented and accepted. It was voted that standing committees on nominations, legislation, new fruits and membership be formed.

After these preliminary exercises were disposed of, the first topic for discussion was taken from the question list.

First question: *Apple orcharding, — will it pay to increase planting of the apple, and, if so, what sorts?* — The discussion took a wide range, all agreeing that there was as much profit in apple growing as in any crop grown. Mr. E. W. Wood considered the Baldwin the most profitable

variety, but it is losing its vigor, and we must cast about for something to take its place. Mr. Hartwell considered the Gravenstein the most profitable apple, his method of harvesting being to let the apples fall on a mulch of hay, and market them in bushel boxes, selling for $1 to $1.50 per box. Mr. Hadwen would not plant Gravensteins on heavy soil: they need some sand in the soil. Other varieties of promise mentioned were McIntosh Red, Sutton Beauty, Palmer Greening, Ben Davis, King, Wagner, etc. The Ben Davis was reported as the longest-keeping red apple, and profitable, but of poor quality; and the King as very uncertain on the thin soils of Massachusetts.

Second question: *The European market for apples, green or evaporated.* — No one present had had experience with canned or evaporated fruit, but all agreed that well-packed good fruit would sell for paying prices if shipped to Europe. Mr. J. Eames would have the apples packed as far as possible from the boiler of the steamer in which they are shipped, in many cases reported the apples stowed near the boiler having come out in a much decayed and injured condition. Careful picking, sorting and close packing are absolutely necessary to success.

Third question: *Is it advisable to plant pears or peaches between apples in the orchard, when forty feet or more apart?* — Several speakers discussed this question, the opinion being that peaches could be planted between the apple, but not pears, as the pear is as long lived as the apple. Mr. Wood suggested currants as a good crop to plant under the shade of fruit trees, giving as an instance the Hittinger Brothers of Belmont, who during the past season grew twenty tons of currants under pear and apple trees.

Fourth question: *Is it desirable to plough orchards late in the season, say in November?* — This question was discussed with a very wide range, but it was generally conceded that it is best to cultivate young orchards continually or until they begin to bear, when many advocated seeding down to grass, and ploughing once in three to five years.

Fifth question: *Causes of and remedy for scald on apples in winter storage.* — Professor Clark thought the cause too much moisture and heat, and would prevent it by getting the

apples into a cool, even temperature as quickly as possible after they are picked.

Sixth question: *Pruning orchards, — is it practised as generally and as thoroughly as it should be?* — This question was passed over rapidly, but it was generally agreed that trees need some pruning, that many prune too much and some too little, and that the time to prune trees is while they are young.

Afternoon Session.

Wm. R. Sessions, secretary State Board of Agriculture, in the chair.

Seventh question: *What is the best winter sweet apple?* — Among the winter sweet apples mentioned were the Honey Sweet, Tolman's Sweet, Danvers Sweet, Green Sweet, Ladies' Sweet.

Eighth question: *Best treatment for old apple orchards that have been in sod many years? If ploughed, how deep?* — Mr. Hinds pastures colts in orchards; he thinks pigs eat off the fibrous feeding roots. Mr. Eames could see no injury from swine in an apple orchard pastured with them for forty years. Mr. Cruickshanks explained Dr. Fisher's method, he not having ploughed his orchard for fifteen years. No grass is carried away, and a liberal dressing of fertilizer, about eighteen dollars' worth per acre, is applied every year. Captain Palmer would treat the land as any other meadow, plough when the sod was run out, manure enough to get a crop of grass and put it in the barn. His best apples grow in his pasture. Many others advocated constant cultivation. Prof. L. F. Kinney suggested a compromise of a strip of turf along the line of the trees, and the central portion ploughed, cultivated and fertilized. Mr. Hinds, whose peach orchard was awarded the first prize by the Massachusetts Horticultural Society in 1895, practises the latter method.

Ninth question: *What is the best way to exterminate the canker worm?* — Paris green applied at the rate of one pound to 100 gallons of the Bordeaux mixture is the cheapest and best remedy. Application should be made just as they are

beginning to hatch out, on average seasons about May 10, and then again in from five to ten days. If tar and ink bands are used, the coating must be kept soft from the middle of October to the middle of April, whenever the frost is out of the ground and the nights are moist and warm. The ink method is simple, cheap and effectual, if properly attended to.

Tenth question: *The best make and form of spraying pump to purchase for general use?* — Prof. J. W. Clark uses the Douglas pump and Vermorel and McGowen nozzle. Prof. S. T. Maynard suggested that there are many good pumps, but it is best to buy one made near home, in case of breakage of parts. The Douglas Pump Company are thoroughly reliable, and have been in the business of manufacturing pumps for fifty to sixty years.

Mr. J. H. Hale, the speaker of the afternoon, now appeared and spoke on "Progressive horticulture." He said that growing choice fruits is one of the fine arts of agriculture. Fine fruit appeals to the higher natures of the people. Fruit must be of fine quality, and put up in attractive packages. The best place to grow fruit is where the market is. In New England we have the soil and conditions for the growth of all the hardy fruits to the greatest perfection, and in our markets the demand is ahead of the supply for fine fruit. To produce fine fruit, one must have a real love for the work. Let the dollar be the last thing in consideration, and it will often be the first. At all events, that enthusiasm which forgets everything but the necessary condition for the production of the finest product possible will be sure of a liberal reward. Cultivation, fertilization, pruning, thinning, spraying, packing and the package are the most important points to consider. There is no profit and can be none in the production of eighty per cent damaged goods, as is often the result of our fruit growing. The manufacturers of cloth who produced even ten per cent of damaged goods would soon become bankrupt. Of small fruits in New England there are now grown one thousand acres where there was one thirty or forty years ago. Our markets are at our doors, and we must do what we can to supply them, or others will

do it for us. The speaker believed that there is more profit in fruit growing in New England than in the south, but made the strong point that thorough work, perfect fruit and business methods are necessary to success.

Evening Session — Grange Hall.

President Draper announced the standing committees authorized at the morning session as follows: Nominations: O. B. Hadwen, Samuel Hartwell, J. W. Clark, James Draper, Geo. Cruickshanks. New fruits: S. T. Maynard, C. W. Prescott, David L. Fisk, H. W. Moore. Legislation: M. P. Palmer, C. L. Hartshorn, C. A. Gleason, Henry L. Parker; Membership: H. A. Cook, Ethan Brooks, A. G. Sharp, Abel F. Stevens, C. W. Minott, Fred W. Johnson, S. C. Damon.

It was voted that a committee of three be appointed to draw up resolutions favoring the State appropriation for the destruction of the gypsy moth. Geo. Cruickshanks, C. L. Hartshorn and Ethan Brooks were appointed.

Eleventh question: *What new points in regard to spraying have been learned the past season?* — This question led to a general discussion of the subject, nearly all agreeing that it is becoming more and more apparent each year that we must protect our crops from insect and fungous pests by the use of insecticides and fungicides. Mr. Morse asked if any one had had experience with the use of arsenate of lead. He had tried it, with poor success. Mr. Minott said that one quart of glucose added to one hundred and fifty gallons of the mixture would cause it to adhere to the foliage.

Twelfth question: *What sorts of fruits have been planted to excess, if any, in Massachusetts?* — No one expressed the thought that any fruits had been planted to excess in Massachusetts, but that there was room for more, if properly taken care of.

Thirteenth question: *Considering the steady decline in prices, what is the outlook for fruit growers in the future? Is it safe to continue extensive planting?* — It was decided by many that prices for choice fruit had held their own and in some cases advanced in the past few years, while there had been a decline in prices of almost all of the necessaries of

life. Gluts often occurred, and we must be prepared with cold-storage houses, evaporators and canning establishments to preserve our crops until the market will demand them.

The committee on nominations presented the list of officers as follows: president, James Draper of Worcester; vice-president, Samuel Hartwell of Lincoln; secretary, S. T. Maynard of Amherst; treasurer, E. W. Wood of West Newton; auditor, C. L. Hartshorn of Worcester; directors, Essex County, E. A. Emerson of Haverhill; Suffolk County, Wm. R. Sessions of Boston; Plymouth County, Augustus Pratt of North Middleborough; Norfolk County, A. F. Stevens of Wellesley; Middlesex County, M. P. Palmer of Groton, Jonathan Eames of Sherborn; Worcester County, Geo. Cruickshanks of Fitchburg, Benj. A. Nourse of Westborough; Hampden County, Ethan Brooks of West Springfield; Hampshire County, F. C. Richards of Williamsburg, J. W. Clark of North Hadley; Berkshire County, A. G. Sharp of Richmond.

It was voted that the secretary cast one vote for the entire list of officers, as presented, which was done, and all were declared elected.

Fourteenth question: *Which are the best, barn-yard or chemical manures for bearing fruit trees, or a combination of both?* — Mr. Hinds uses chemicals, largely bone and potash, for orchards, and pastures colts in them, with good results. Other members discussed the subject, bringing out the points that the kind of land makes much difference as to what and how much fertilizing material should be used; potash tends to make fine and well-colored fruit; nitrogen large size, but not so good quality.

Fifteenth question: *Should new varieties of fruits be tested at the experiment stations before they are offered to the public?* — It was generally agreed that they should, but it was suggested that duplicate tests be made in different parts of the State, all agreeing that some protection is needed to save the fruit grower the great expense of buying at high prices every new thing that is offered, when in nine cases in ten they are inferior to the old standard sorts. The results obtained in tests at Amherst proved generally correct for

other sections of the State, but duplicate tests are needed, to hasten the work and make it more exact.

As to varieties of fruits, the winter pears best suited to New England conditions mentioned were Anjou and Dana's Hovey; of raspberries, the Cuthbert; of blackberries, the Snyder, Agawam and Taylor's Prolific; of strawberries, the Haverland, Bubach, Greenville, Marshall and Brandywine.

Of the Japanese plums, it was reported that the fruit buds were all killed and the ends of some of the canes on young trees.

Training the grape by the one or two arm renewal system was illustrated by a wire fastened to the side of the hall. The principal advantages of the one-arm renewal system (Fig. 1) are: first, simplicity and saving of labor in training and tying up, every part of the vine being easily seen by the operator; second, the fruit and leaves are carried up into the sunlight and air, where they are less subject to the attack of mildew and rot, are out of the reach of poultry, and safe from the spatter of the soil during heavy showers; third, only two wires are needed, and the labor of pruning is much less than where several arms are employed; fourth, as large a crop of grapes can be grown as with the many-arm system. In Fig. 1 a part of three vines is shown. The upper cane of last season's growth is represented in fruit,

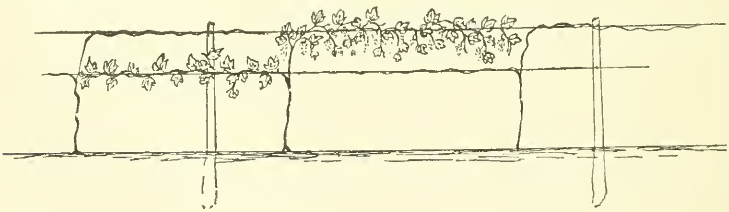


Fig. 1.

while the new cane is trained on the lower wire. The fruiting spurs are pinched off as soon as the first leaf is found beyond the last bunch of blossoms, and whenever new shoots start from these laterals one leaf is allowed to grow. The laterals on the new canes are treated in the same way, and the end is stopped in growth as soon as it is a foot past the next vine toward which it is growing. At the end of the

season the fruited cane is cut away and the new cane from the lower wire is brought to the upper wire for the next season's fruiting.

Girdling grapes, to hasten their ripening was explained. Grapes are thus hastened in time of ripening from one week to ten days. It has been practised for fifteen years by Mr. Wheeler of Concord, and is the only way that he can secure his crop from frost in the fall, as his vineyard is only a few feet above the river that flows near.

Remedy for apple maggot or railroad worm, so called: destroy all fallen fruit and pick all marketable fruit before it gets at all mellow.

Cold-storage houses with ice are used by Messrs. Hunt, Eames and others. Drip was prevented by having ice on slats and the water caught on sheet iron underneath. Mr. Hunt used waste water for cooling milk. Mr. Hartwell believed that there was an outlet for all the fine fruit we can grow. Captain Palmer would grow fruit in connection with general farming. The farmer should have a good deal to sell and considerable variety, that his income may be distributed through the year. Would advise young men to plant fruit trees. Use them well and they will use you well. Intends to continue planting, not a few trees each year, but several hundred.

FRIDAY — *Morning Session.*

The closing day began with President Draper in the chair. The report of the committee on gypsy moth resolution was called for, and the following resolutions were presented and adopted: —

Whereas, The committee on agriculture in the Massachusetts Legislature has under consideration the matter of an appropriation for the extermination of the gypsy moth in this State; therefore,

Resolved, That we, members of the Massachusetts Fruit Growers' Association, in annual meeting assembled, earnestly request that a liberal appropriation be made for carrying on the work, that the ravages of this dangerous insect pest be checked.

Resolved, That we recommend that the proper legislative committee be requested to take such measures as will enlist the co-opera-

tion of the United States government in this work of exterminating this pest, as we believe it will be a national calamity if allowed to spread over the country.

The speaker for the morning, Mr. C. H. Perkins of Newark, N. Y., a man of wide experience in handling the apple crop and in the evaporating and canning business, was then introduced, and discussed in an able manner "The preservation, storing and marketing of fruit." A brief report of this address we copy from the "Worcester Evening Gazette:"—

Mr. Perkins said the subject was an immense one, and more than he could present in the time allotted for the discussion. He first considered the question of cold storage, basing his remarks upon an experience of thirty years in this line of agriculture. He would not be understood as referring to the large cold-storage houses, where fifty thousand bushels of pears were kept for canning, but rather the neighborhood cold storage, the co-operative plan. The advantage to be gained by co-operative cold storage was to preserve the trade, for the Canadian shippers stood ready to monopolize that trade if they saw an opportunity.

He spoke of the extensive apple orchards of the country and of the great demand from European markets. The value of the evaporated fruit was demonstrated from a financial stand-point when the speaker said that in one county in New York State of not more than fifteen towns the value of the product was fully one million dollars. He told of a frost-proof storage house that he had built to store ten thousand barrels of apples. When oranges were sold at a cent a piece, the cry was heard that it would be no use to raise apples. As a matter of fact, apples still sell for more than oranges, not only in this country, but in Europe.

When discussing evaporated apples, the speaker exhibited a number of specimens. An evaporating plant varies in expense, as there are many kinds of evaporators. Those costing from fifty dollars to one hundred and seventy-five dollars will evaporate fifty bushels a day; those costing one hundred and seventy-five dollars to two hundred and fifty dollars, from one hundred to one hundred and fifty bushels a day; and those costing three hundred dollars will evapo-

rate one hundred and fifty bushels a day. There are machines that cost eight hundred dollars that operate by steam, with a capacity of two hundred bushels a day. The cost of evaporating is from one and one-quarter to one and one-half cents a pound.

He said that for canning a better grade of apples was used than for evaporating purposes. The profit, however, was great, and in this line of goods Great Britain takes twenty thousand dozen annually. These canned goods find their way on the continent also. There was equally as good profit in canned pears. New England Bartlett pears have the best flavor and are in greater demand. In canning, the apples are cored and quartered, placed in the gallon can, and water is put in. The can is sealed and placed in a tub or vat and boiled. One and one-half bushels of apples will make twelve gallon cans. For canning, the speaker preferred the Baldwin.

He said that the wastes from the evaporators were used to make the cheap jellies, and, strange to say, from apples, strawberry, raspberry and other jellies were made, simply by using the flavor of the fruit desired. He said that this was not so bad as it is in England, where turnips form the basis, instead of apples.

The cold-storage house described by Mr. Perkins (Fig. 2) is a frame building on a solid foundation, the first posts being four inches thick and fourteen feet high. This is covered with paper and sheathing boards. Four-inch studs are again set up on both sides of this wall, and covered with paper and sheathing, thus making a wall about sixteen inches thick, with three four-inch air spaces (as shown at *A*). If desired to make this building more ornamental, clapboards may be put outside, thus adding another thickness of paper and sheathing. The roof is built in the same manner, with three four-inch air spaces and a ventilator, and double glass windows (*B*) on the ridge for light and ventilation. One or more double doors may be provided. Any common frame building could be utilized in this way, by covering both sides of the frame and putting up studs outside and inside of this covering and sheathing up. The foundation should be firm, and below the action of frost outside. This

house, after the temperature has been lowered by opening the ventilators in the roof and the doors near the ground at night and closing in the morning, will scarcely vary in temperature twelve degrees during the fall and winter months. In such a house, cider apples, the poorer two grades used for evaporating and the best two grades used for canning, are kept with little or no loss until they can be converted into marketable products. Mr. Perkins made the point very

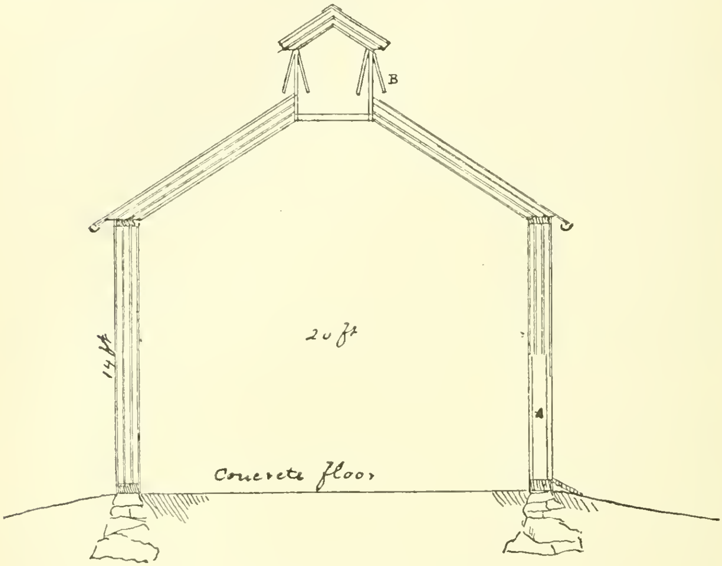


Fig. 2.

clear that the great advantage of utilizing the seconds and medium grades of apples for canning and evaporating is that the choice apples only are put on the market, and such choice fruit will sell for more than enough above the ordinary grades to pay the cost of working up the former into marketable products. This gain in price of choice fruit should be permanent, on the principle that the more such fruit the people have the more they want, and both demand and prices are increased.

Afternoon Session.

Vice-president Hartwell was in the chair. The address was made by Prof. S. T. Maynard of the Massachusetts Agricultural College, on the propagation, growth and pruning of fruit trees, illustrated by samples of seedling stocks used for budding, etc., the different methods of grafting, by trees as they come from the nursery, showing No. 1 and No. 2 trees, June-budded and autumn-budded peach trees, one and two year old grape vines, currants, etc. The various methods of propagation and training from the seed to time for planting in orchards were described in detail. The young trees were pruned for planting, and the subject of pruning trees in the orchard up to two or three years of age was discussed by the speaker; when he called upon Prof. J. W. Clark to discuss the best methods of pruning trees, in which he had become very skilful by the care of the largest apple orchard in this State.

The principal reason why this subject was presented is that there is not a single nursery in the State where the fruit trees sold are largely grown by the nurseryman selling them; and there seems to be a field for young and enthusiastic men in supplying from our own soil more of the immense quantity of trees that are planted every year. In every village and hamlet the nursery agent from distant nurseries comes annually without fail, with his highly colored plates of fruits, wonderfully superior to anything ever before seen; and hundreds of thousands of trees and shrubs are sold to our people that might be grown on our own soil, where they could be delivered to the planter in a condition that would make their growth and perfection, with a fair amount of care and skill, a certainty. In almost every large town or city is to be found the local nurseryman, who supplies such local trade as he can secure; but the greater part of his stock, too, is first grown in some New York or other distant nursery, and these, after a year or two of growth in the local nursery, are sold as home-grown stock. Such trees are more valuable than those generally supplied by the travelling agent, and give good satisfaction, but they are far less valuable than well-grown trees planted and budded

within an hour's ride of the land on which they are to be planted. These facts led the writer to present this subject at the winter meeting, in the hope that many young men — for there is room for considerable competition in the business — might become interested in the work which, with its many trials, has a great fascination for the true lover of horticulture, and might prove a source of large profit and of great benefit to the fruit growers of the State.

To further this interest, the Agricultural College now offers an elective course of study in nursery work to the members of the senior class, and a short winter course is to be open to young and old the coming winter, where any one who wishes may take up the study of any line of horticulture, including special work in nursery and orcharding. With an equipment of the largest collection of varieties of fruit to be found connected with any agricultural college in the country; all of the labor-saving implements for cultivation, pruning, spraying, etc.; a nursery in which are found all kinds of fruits and ornamental trees and shrubs; and with no tuition, only the expense of board and incidentals, — no young man, who has time and is interested in any line of agriculture or horticulture, can afford to let another season pass by without taking advantage of this offer of a free education that shall fit him for some line of the most interesting and healthful, and, when conducted in a business-like way, profitable, calling.

At this, the first annual meeting, forty-seven new names were added to the membership. The meeting was declared adjourned, subject to call for a field meeting in June, at some place to be decided upon in the near future.

Spring Field Meeting.

A field meeting of the association was held at Fitchburg, June 12, 1896, about seventy-five members being in attendance. The first visit was to the noted fruit farm of Dr. Jabez Fisher. The doctor explained his method of pruning and training the grape, and showed his admirably constructed cold-storage room, his greenhouses and the fruit cellar where his crop of grapes for the last thirty years or more has been stored until sold. The pear and apple orchards were also visited, and the doctor's method of orchard management observed, a description of which may be found in Agriculture of Massachusetts, 1889, page 11.

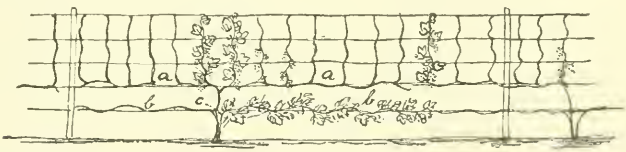


FIG. 3.

Dr. Fisher's method of training the vines is illustrated by Fig. 3, which shows a part of two vines. The fruiting canes of last season's growth, *a*, *a*, are trained each way from the centre of the vine on the second wire of a five-wired trellis, which is about two and one-half feet from the ground. The laterals which are to bear the fruit are trained as they grow to the wires above in a vertical position. When these lateral canes have reached the top wire they are pinched off, and if any growth starts at any point on these canes it is pinched off as soon as one new leaf is formed. The canes that are to bear the fruit the next season, *b*, *b*, are trained along the lower wire, and if laterals start into growth upon them they are also pinched after one leaf has been formed, and all other shoots that start are pulled off. Thus the growth is all forced into the most important parts of the vines, *i. e.*, those canes bearing the fruit and that are

to produce the fruit the following season. After the fruit is gathered the fruiting canes are cut off at the point *c*, and the new canes from the lower wire are brought into place on the second wire, ready for the production of fruit in their turn. The new canes grown each year may be started from the main cane near the first wire or from the ground, as may be most convenient, the rule generally followed being to take the strongest shoot that starts from either place. By this system of training there is no waste or loss of wood, the fruit is brought up where it may be easily inspected, and where a full exposure to sunlight and air will aid in protecting it from fungous diseases.

The party then proceeded to the fruit farm of the late Geo. B. Andrews, about half a mile farther to the north, and on much more elevated land. Here were found healthy vineyards of Concord, Worden and Delaware vines, of the latter variety about three acres, probably the largest and best vineyard of this variety in the State, and also orchards of the domestic and Japanese plums, apples and pears. The farm is situated at a very high elevation, where late frosts in the spring and early frosts in the fall seldom injure the grape crop. The apple and pear orchards were inspected. It was found that many of the Japanese plum trees, of which some seventy-five trees had been planted two years previously, were badly injured by the previous cold winter.

The company then drove to the beautiful home farm of Mr. A. A. Marshall. A bountiful lunch was here provided, and after the repast speeches were made by Messrs. Draper, Hadwen, Hale, Dr. Fisher, Secretary Sessions of the State Board of Agriculture, and others. The party was then conducted by Mr. Marshall to his fruiting strawberry field of seven acres. This field lies on a slope to the south-east, and was planted in the spring of 1895, the plants being set four by five feet. Not a weed was allowed to grow, and the plants soon covered the ground with a mat of runners. During the latter part of the summer and early fall the beds were thinned out, leaving the plants about six inches apart, in rows about three feet wide, thus leaving a walk between the rows about two feet wide. The fruit was just beginning to ripen, and the prospect was that the crop would not be

large, but that it would be of fine quality. Mr. Marshall has his land equipped with an irrigation system, consisting of main pipes arranged along the upper sides of the beds with a three-fourths inch brass faucet at the end of each row, so that during droughts a continuous stream can be run along each row of plants. After the upper section of the bed has become saturated, the pipes are arranged across the field lower down, and water thus applied until the whole field is irrigated. The supply of water is obtained from the city works, at a cost of ten cents per thousand gallons, and an unlimited supply guaranteed. In addition to the fruiting field, Mr. Marshall showed the company a newly set field of ten acres, which was also provided with irrigating pipes with faucets for each row. The system of planting here practised consists in setting only strong, healthy plants, high manuring and the most thorough cultivation. Each plant is given an abundance of space to reach its greatest perfection. The young plants only are preserved for fruiting, the old plants being cut out when the thinning is done.

From Mr. Marshall's place the party went to the place of Mr. T. J. Sanderson, where some very vigorous and healthy plum trees were inspected, they being literally covered with fruit.

The great lesson of the day, seen more or less at every place visited, was that of the most thorough and skilful cultivation, high fertilization and the production of only fancy fruit.

Fall Field Meeting.

A fall field meeting was held at Concord, Sept. 11, 1896. About one hundred members and friends attended. The first place visited was that of Mr. Frank Wheeler, where his greenhouses were first inspected. From the greenhouses the party proceeded to the vineyard and asparagus field, about half a mile away, across the river. This vineyard is of great interest to all fruit growers, from the fact that girdling the fruiting canes to hasten ripening has been practised on a large scale for eleven years. The land is situated only a few feet above the level of the river flowing near, and this practice became a necessity to save the crop from early frosts in the fall, very few ripe crops having been

obtained from the vineyard until girdling was practised. Mr. Wheeler gave a brief history of the vineyard, the method of cultivation, pruning and training, and explained the process of girdling. The work of girdling is done early in July, and consists in removing a ring of bark on the fruiting cane, from one to two inches wide, as near the fruit as possible. This is done by circling the knife about the cane,

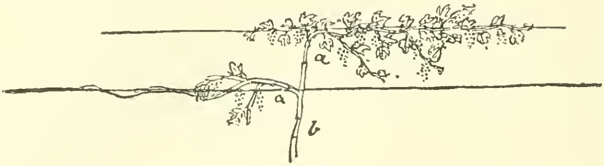


FIG. 4.

cutting just through the bark in two places *a*, *b* (Fig. 4), and removing the ring with the point of it, and this can be quickly done after a little practice. Each cane may be girdled as at *a*, *a*, or the main cane below the fruiting arms may be treated as at *b*.

Mr. Wheeler's method of training is perhaps unlike that practised by most vineyardists. Three series or systems of

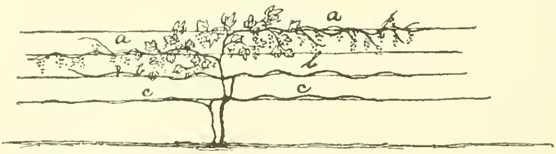


FIG. 5.

growth are provided, — *a*, *a* (Fig. 5), the fruiting canes; *b*, *b*, the new canes for the next year's crop; and a supplementary growth, *c*, *c*, to supply the root development that is cut off by the girdle of the large fruiting canes. This supplementary growth is found necessary, for if only the new canes that are to fruit the next season were left below the girdle, the root formation would be so small that these canes would start with little vigor, the crop would be greatly reduced, and another full season be needed for the vine to recover from the effects of girdling. Mr. Wheeler stated that under this practice his vineyard has steadily increased in vigor and productiveness.

The next place visited was that of Mr. Geo. Wright, where was found a vineyard containing a greater number of varieties than Mr. Wheeler's, and trained in a slightly different manner. The vineyard was in a very high state of cultivation, and a large crop of fruit was nearly ready for market, — some had already been shipped. Mr. Wright has practised girdling for several years, although his vineyard is situated on much higher land than Mr. Wheeler's, but he finds it necessary to girdle to hasten the ripening of the fruit, so as to get it into the markets before the glut from the New York State shipments.

The party was then driven to the home of Mr. Chas. Prescott, where a lunch was to be provided under the shade of his beautiful ornamental trees. Before the dinner call was sounded some of the party inspected Mr. Prescott's well-kept grounds. The especially attractive features were the extensive asparagus field and the blackberry plantation. Mr. Prescott reported remarkable success in keeping down the asparagus beetle by placing coops of chickens at frequent intervals about the fields.

After dinner short speeches were made by several members of the association and invited guests. The party was then driven to the historic North Bridge, where the shot was fired that was heard round the world. The barges were drawn up around the statue of the "minute man," and a brief account of the events of that historic place given to the company. From the bridge the party was driven to the home of Mr. W. H. Hunt, where further refreshments were offered, and, after viewing the beautifully located lands with their abundant crops from the barges, they proceeded back through the main street of this historic town, passing the "Old Manse," the home of Ralph Waldo Emerson, the "House of Seven Gables," the "School of Philosophy," the home of the late John B. Moore and that of the father of the American grape industry, — the late Ephraim W. Bull, the originator of the Concord grape. Here the party dismounted, and, after inspecting the place, grouped themselves about the original Concord vine, and were photographed.

The company then proceeded to the home of our vice-

president, Mr. Samuel Hartwell, "Gravenstein Farm." Here on every hand was seen the evidence of thrift and successful fruit growing and market gardening. The fruit trees, principally of apples, were heavily loaded with fruit, especially the winter sorts, the Gravensteins and other fall varieties having been largely harvested. The unfortunate condition of the apple crop in Massachusetts was as perfectly illustrated in the Baldwin trees on this farm as perhaps could be found anywhere in the State, the trees literally breaking down under their burden of fruit, the number being so great that they could not possibly mature of good size or color, and, to add to the difficulty, the little insects known as the leaf hoppers were feeding in such numbers on the leaves and fruit that the growth action of the trees was almost wholly suspended.

Mr. Hartwell showed the company some eighty or more bushel boxes of Gravenstein apples nicely packed ready to be loaded upon his market wagons to be taken into Boston, where he had already sold about fifteen hundred boxes at prices ranging from 50 cents to $1.50 per box. The perfection of the fruit and its attractive packing was a sure guarantee of its being sold at the highest market price. His method of harvesting the Gravenstein is to allow the well-colored fruit to fall upon a mulch under the trees, when it is gathered each day and carefully packed in the ordinary bushel market box. Many of his trees of this variety he finds to be seriously injured near the ground, probably by the frost, the bark being started off, and in some cases they have died from the injury.

A vote of thanks was given Mr. Hartwell and the other members of the committee of arrangements for so enjoyable and profitable an entertainment.

Four new members were added to the list at this meeting.

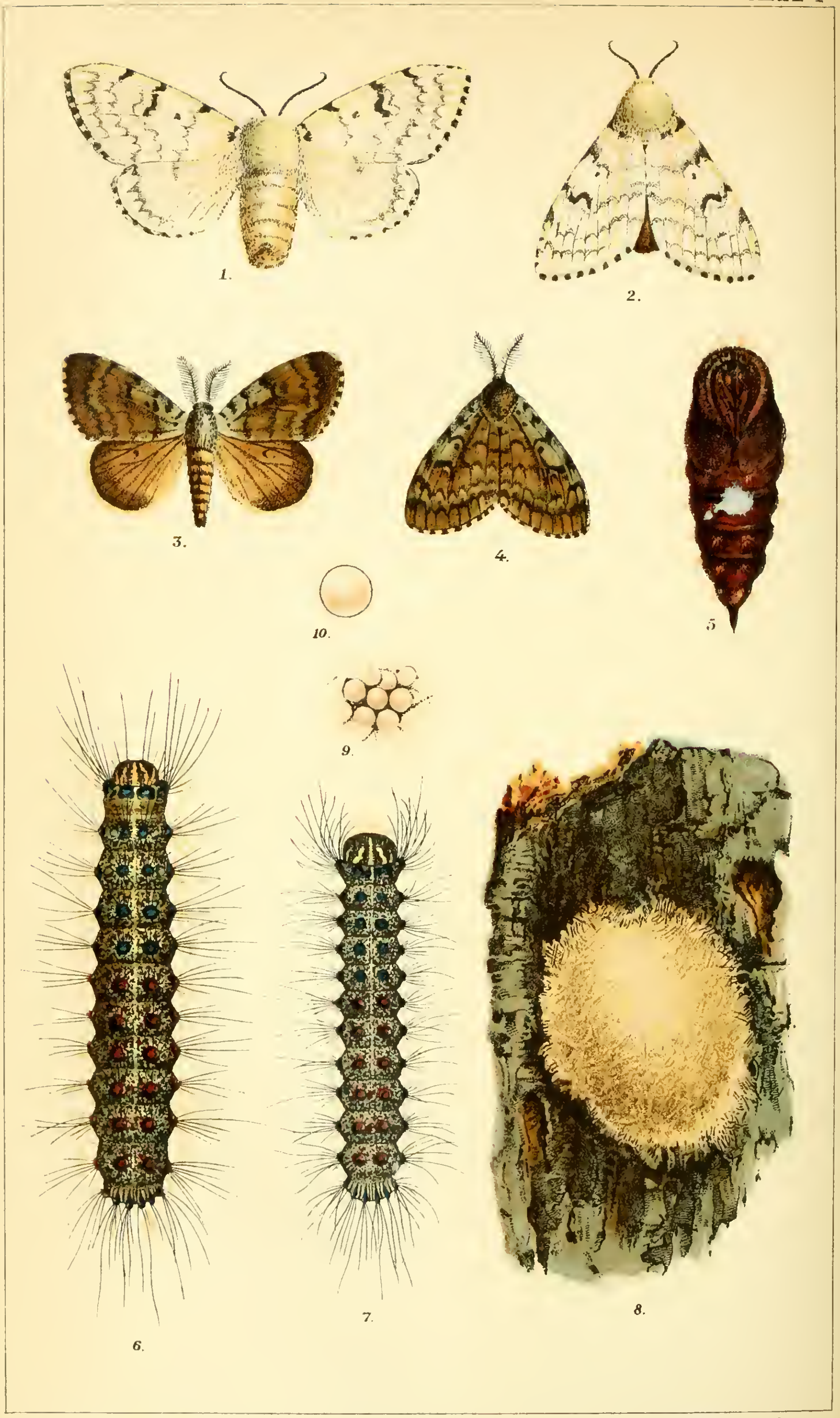
REPORT

OF THE

STATE BOARD OF AGRICULTURE

ON THE WORK OF

EXTERMINATION OF THE GYPSY MOTH.



Drawn by Joseph Bridgham.

Geo. H. Walker & Co., Boston.

GYPSY MOTH

An Explanation of Plate I, with a Short Description of the Different Forms of the Gypsy Moth and its Feeding Habits.

The Eggs.

[Fig. 8, cluster of eggs on bark; Figs. 9 and 10, eggs magnified.]

The eggs are deposited in clusters, averaging about five hundred eggs each, and covered with yellow hairs from the body of the female moth. These egg-clusters are usually found in sheltered places on the bark or in the crevices and cavities of trees, stumps and undergrowth; also on fences and buildings and in the crevices of stone walls and other objects, near the plants or trees on which the insect feeds. The eggs are laid in July, August and September, and hatch after the foliage starts in the late spring or early summer of the ensuing year; therefore the insect passes the fall, winter and early spring in the egg.

The Larva or Caterpillar.

[Figs. 6 and 7.]

When first hatched the caterpillars are less than one-fifth of an inch in length. As they grow larger they may be seen in clusters upon the trunks and branches of trees or in the cavities and other hiding places where they gather in June, July and the first part of August.

The Pupa.

[Fig. 5.]

The caterpillar when fully grown sheds its outer covering and becomes a pupa or chrysalis. This usually occurs in July or August. The pupa may be found in the same situations as the eggs. In Massachusetts the insect usually remains in the pupal state from ten to thirteen days, emerging as a moth at the end of that period.

The Moth.

[Figs. 1 and 2, female; Figs. 3 and 4, male.]

The female moth usually deposits her eggs very near the abandoned pupa case, and within a few hours after emerging from it. She dies soon after. The male is a rapid flyer. The female does not fly.

Habits of the Caterpillars.

The gypsy moth feeds only when in the larval or caterpillar state. In Massachusetts the eggs of the gypsy moth begin hatching about April 20, and the young continue to emerge until the middle of June. The length of larval life varies somewhat according to circumstances, but probably averages ten weeks; therefore the feeding season in this country lasts about four months. When the caterpillars are first

hatched from the eggs they are light in color and covered with whitish hairs. In a few hours they assume a dark hue. They usually remain on or near the egg-cluster until they change in color, and should the weather be cold they sometimes remain for several days in a semi-torpid condition upon the egg-cluster. If the temperature is favorable they usually search for food before they are twenty-four hours old. During the first few weeks of their existence they remain most of the time on the leaves, feeding mainly on the under side. Their feeding habits are so uncertain that no rule can be given which will apply to all individuals, but before they are half-grown they generally begin to manifest their gregarious instincts. At that time and for the rest of their existence as caterpillars they spend a large part of the day clustered in sheltered situations, and feed principally at night, going up the trees and out on the branches after dark and returning before day-break. Where they are so abundant that the food supply is insufficient they evince much restlessness, and feed in numbers during all hours of the day and night. They may then be seen hastening to and fro, both up and down the trees. Those which have fed sufficiently are at once replaced by hungry new-comers, and the destruction of the foliage goes on incessantly.

At such times the trunks and lower branches of trees are covered with a moving mass of caterpillars, hurrying throngs are passing and repassing, and nearly every leaf or denuded stem bears up one or more of the feeding insects. The rustling caused by their movements and the continual dropping of excrements is plainly audible. On tall trees the larger caterpillars appear to crawl to the higher limbs, and they seem to prefer to feed well out toward the end of the branches. They do not feed gregariously except when in great numbers; therefore they seldom strip one branch, as do the larvæ of the *Euvanessa antiopa*, but scatter throughout the trees, eating a little from each leaf. Early in the season, when they are small and few in numbers, their ravages are scarcely noticed; but as they grow larger and more numerous, their inroads on the tree decrease the foliage area night by night, until suddenly all the remaining leaves are eaten, and the tree is stripped in a single night.

Food Plants.

The gypsy moth is known to destroy the foliage of nearly all native and introduced trees and plants of economic importance. The list of its food plants includes nearly all evergreen and deciduous trees, most bushes, shrubs, vines and vegetables, and it has been seen to eat grass and grain. Wherever the caterpillars become numerous they move slowly, devouring nearly every green leaf and bud as they go. They feed during a much longer season than the canker worm or the tent caterpillar. In the months of June, July and August, 1891, trees which had been stripped early in the season and whose leaves had again put out were again defoliated by these caterpillars and kept bare all summer; therefore not only was all prospect of a fruit harvest destroyed, but many trees were killed by this continual defoliation.

Commonwealth of Massachusetts.

To the Massachusetts State Board of Agriculture.

The committee in charge of the gypsy moth work, committed to the Board of Agriculture by the Legislature, herewith presents the report of expenditures and of work performed for the year 1896.

On the first of January, 1896, there remained unexpended, of the appropriation of 1895, $39,722.09. This was retained with the expectation that the sum would be sufficient to maintain the reduced force of 121 men to continue such work as could be done during suitable winter weather until the Legislature should make an appropriation for the season's work. In January, February and the first half of March much effective work was done in the way of destroying the eggs of the moth upon the trees, cutting and burning worthless, decayed, infested trees and underbrush, and preparing infested localities for the summer's work. As the season wore on and most of the appropriation became exhausted, it was found necessary to further reduce the number of men employed, thus greatly handicapping the effectiveness of the work.

The Board of Agriculture had unanimously adopted and approved the report of the gypsy moth committee, recommending to the Legislature an appropriation of $200,000. The Board had also adopted resolutions, unanimously recommending that whatever appropriation, if any, the Legislature saw fit to grant, should be promptly forthcoming, as the work had in the past been hindered nearly as much by delay as by reduction of the appropriations. The committee reported to the Legislature on the work of the season of 1895, placing the report in the hands of the clerk of the Senate on the first day of the session. The report was thus pre-

sented at the first available opportunity, ten days in advance of the time required by law, so that the Legislature might have every opportunity for the most speedy action.

In March, the appropriation of 1895 being exhausted, and the Legislature having taken no action, most of the men were discharged. This delay was a repetition of the experience of past seasons, except that the loss of time was greater. This lapse of the spring work was unfortunate in the last degree, and was productive of most serious results.

An emergency appropriation of $10,000, to continue the work until the Legislature should provide for the work of the season, was finally granted, and became available April 28. With this amount good work was done during the month of May, in burning over the ground in infested localities in the woods, thereby destroying the moth eggs concealed upon the ground or near it, and putting much of the territory into such condition that little damage was done by the moth during the season. In several of these places no caterpillars have since appeared. This appropriation was not sufficient, however, to do one-half of the work that was absolutely necessary at that time, and many large colonies in forested land, in the inner towns, were necessarily neglected. There the caterpillars hatched and later in the season became very destructive. The appropriation of $90,000 for the work of the season, less than one-half the sum recommended by the Board, finally became available June 4. It was then too late to carry out the plans made for the season's work. This delay, together with the small amount of the appropriation, necessitated a complete change in those plans. Moreover, extra work was made necessary by the hatching of the eggs, which it had been planned to destroy in the spring had the appropriation been available at that time. Burlap was purchased and applied as quickly as possible to the trees in all of the outer towns of the infested region, and in Everett, which had been necessarily somewhat neglected the previous year. Before the burlap had all been put on in these towns the caterpillars had begun to cluster. In order to do the necessary work it was imperative to increase largely the force of men at once, and to put all hands at work killing caterpillars under the burlaps in the outer

towns. While this was being done, the woodland in the inner towns was necessarily neglected, with the result that in places where no egg-killing had been done earlier in the season, owing to the exhaustion of the appropriation, the caterpillars were doing much damage and were also spreading over more territory.

The small amount of the appropriation would not admit of exterminative work all over the infested territory, and, in order to prevent the moth from spreading into new territory, outside the towns already infested, the outer towns have been closely attended to throughout the season. The condition in these towns is encouraging. Most of the colonies in the outer towns are apparently exterminated and the spread of the moth into new territory has been prevented. We have, however, to report that two colonies have been found in Brookline, a town adjoining the boundary of the infested territory as heretofore reported. The discovery of the moth in Brookline in 1896 is not to be taken in any sense as indicating that the insect has spread into that town from older infested territory since the committee's last report, or within a year. The two colonies are not newly established, but are several years old; and, had the committee had sufficient means to carry out their plan inaugurated several years since, viz., to carefully examine all towns contiguous to the outermost infested towns, both these colonies would have been found before. This examination has been pursued from year to year as means could be spared from the work in known infested territory, and Brookline has this year had its first thorough examination. This work has been repeatedly reported as necessary, and lack of means only had prevented its being done in Brookline previous to 1896. An effort has been made during the season to stamp out these colonies, but considerable work will need to be expended on them the coming year.

Every effort warranted by the amount of money available has been made to prevent injury by the moth in the central infested towns, and as far as possible to prevent an increase in the number of the moths. This effort has been successful in the inhabited and cultivated territory. The same cannot be said of the woodland, of which we have heretofore re-

ported that there were not less than fifty square miles. In several places in the woodland the trees were entirely stripped of foliage and in some cases the second crop of leaves was eaten. Where the trees have been stripped two years in succession we find that many of them are dying. This condition was not unexpected by the committee. Former reports have from year to year shown that the woodland was the most serious menace to possible extermination and that it was likely to be found infested in many places.

The committee has each year warned the Legislature that with reduced appropriations this woodland could not be attended to and must remain a breeding-place for the moths, from which they would be likely to spread into adjoining territory: and that, even if the cultivated land adjacent to these woodlands was cleared of the moth, it was still liable to become reinfested. In no year since 1892 has the committee had an opportunity to carry out the plans made for the work of the following season. In 1893 the committee asked for $165,000; only $100,000 was appropriated. In 1894 $165,000 was asked; $100,000 was appropriated. In 1895 $200,000 was asked; $150,000 was appropriated. In 1896 $200,000 was asked; $100,000 was appropriated. An examination of the reports will show that these sums were granted after long delays, so late in the season that it was impossible to use the reduced amount to the best advantage. The result is that extermination can now only be accomplished by the expenditure of a sum very much larger than might in the opinion of the committee have been sufficient had the recommendations of former reports been followed. The committee feels certain that an annual appropriation of $100,000 will not accomplish extermination, and it is doubtful whether that sum annually expended will prevent the moth from spreading into new territory unless it is promptly made available, so that every possible advantage may be taken of good weather and other favorable conditions to prosecute the work economically.

The committee is on record in former reports as believing that the only sure way to prevent the moth from spreading into new country is to do everything possible in every infested locality to completely eradicate the pest. This is

still the unanimous opinion of the committee. To carry out this plan the committee recommends the appropriation of $200,000 for the work of 1897. As the appropriation for 1896 is almost exhausted, in order to continue the work economically it will be necessary that a part at least of the appropriation be made immediately available; otherwise, the present force of trained and experienced employees must be discharged at once, and the very important work that can be done only before the caterpillars hatch out will again be left undone. Leaving this work undone will put the work of the whole season at a great disadvantage, and in part undo the work of the last five years. The committee has, in former years, sought advice of the eminent economic entomologists of the country, and are warranted in stating that the present methods of work are approved by all those economic entomologists who have had an opportunity to become familiar with them.

The effort of Massachusetts to exterminate this pest has attracted wide attention among the economic entomologists of the country, and with one accord they advise a continuance of the work. At the last annual meeting of the Association of Economic Entomologists, held at Buffalo, Aug. 22, 1896, after thorough discussion, a resolve was unanimously passed, commending the work already accomplished and urging its continuance.

At the National Farmers' Congress, held at Indianapolis, Ind., Nov. 10, 11 and 12, 1896, the matter was considered, and the following resolution was adopted: —

Resolved, That the Farmers' National Congress views with alarm the ravages made by the gypsy moth upon the trees and foliage in the New England States,* and petitions the Congress of the United States to cause an investigation of the subject to be made, and to take such measures for the extermination of the pest as may seem wise, as its spread over the country would prove a national calamity.

The experimental work has been continued in charge of Mr. A. H. Kirkland, assistant entomologist to the committee,

* This is an error, as the gypsy moth in this country is confined to a small area in eastern Massachusetts.

under the direction of Prof. C. H. Fernald. Particular attention has been given to the investigation of various forms of poison, with a view to discovering an insecticide that will be more effectual in destroying the gypsy moth caterpillars than those poisons heretofore in general use. Considerable success has attended these experiments, and insecticides have been perfected that promise to be of great value in future work. Much work has also been done in seeking for and encouraging native parasites that prey upon the gypsy moth, and in studying their life history, with the hope that something more may be found that will give effectual aid in destroying the pest.

For details of the work of the past year, reference is made to the reports of Prof. C. H. Fernald, entomologist, and E. H. Forbush, director, presented herewith as a part of the report of the committee.

The committee desires to put on record here its obligation to Prof. C. H. Fernald and Mr. E. H. Forbush for the eminently satisfactory manner in which they have discharged the onerous duties devolving upon them in conducting the work which the Legislature has entrusted to the committee of the Board of Agriculture.

The following is the financial report of the gypsy moth committee of the State Board of Agriculture for the year 1896: —

Financial Report for 1896.

Balance on hand Jan. 1, 1896,		$39,722 09
Emergency appropriation, April 28, 1896,	$10,000 00	
Appropriation June 4, 1896,	90,000 00	
		100,000 00
		$139,722 09

Expenditures.

Wm. R Sessions, expenses,	$16 37
Augustus Pratt, expenses,	85 05
E. W. Wood, expenses,	22 07
John G Avery, expenses,	145 95
F. W. Sargent, expenses,	59 94
S. S. Stetson, expenses,	57 50
C. H. Fernald, expenses and remuneration,	655 65
Amount carried forward,	$1,042 53

Amount brought forward, ...	$1,042 53	
E. H. Forbush, director, salary, . . .	2,400 00	
Travelling expenses of director and men, .	4,793 56	
Teaming, livery and board of horses, . .	3,132 22	
Wages of employees, ...	104,975 87	
Rent of storehouse and office, . . .	466 50	
Supplies, tools, insecticides, etc., . . .	14,061 56	
Balance on hand Jan. 1, 1897, . . .	8,849 85	
		$139,722 09

E. W. WOOD,
S. S. STETSON,
JOHN G. AVERY,
AUGUSTUS PRATT,
F. W. SARGENT,
WM. R. SESSIONS,

Committee of the Board of Agriculture in Charge of the Gypsy Moth Work.

Report of the Entomologist.

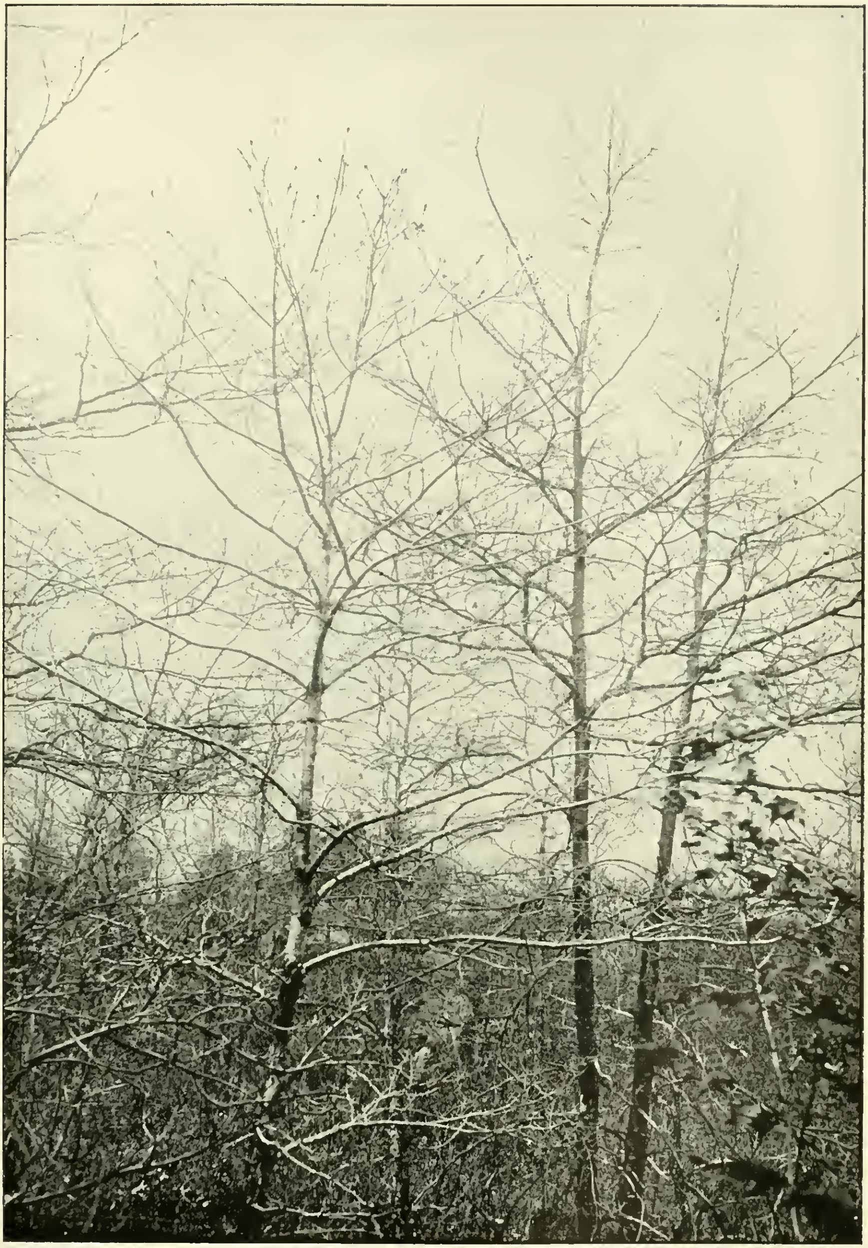
To the Committee on the Gypsy Moth.

Gentlemen: — During the past year all has been accomplished towards the extermination of the gypsy moth that could possibly be done, or that could have been expected with the small amount appropriated by the last Legislature. For several years past the appropriations asked for this work have been cut down from one-fourth to one-half, but no change has been made in the law which requires the committee to work for the extermination of this insect.

There is no question but that the gypsy moth is one of the most destructive and expensive pests that could have been brought into this country, and only the most active and vigorous measures are of any avail against it. It is claimed, by some who have little or no knowledge of the matter, that it is not possible to exterminate this insect; but I do not know of any economic entomologist, who has made a thorough, personal investigation of the work, who does not believe that extermination is possible if the Legislature appropriates sufficiently large sums of money, making them available when needed in the work.

At the last meeting of the Association of Economic Entomologists, held in Buffalo, N. Y., Aug. 22, 1896, after a full discussion of the work on the gypsy moth, the following resolutions were presented by Dr. John B. Smith, professor of entomology in Rutgers College and entomologist to the New Jersey State Agricultural College Experiment Station, and unanimously adopted: —

Resolved, That in the opinion of this association the work done by the gypsy moth committee in Massachusetts is of the utmost importance and value, not only to that State but to all the surrounding States and to the country at large.



A view in the Lynn woods showing how the Gypsy Moth strips nearly all trees and plants. Many of these trees are now dead or dying. (See page 388.)

From a photograph taken July 10, 1896.

Resolved, That in our opinion the cessation of the work of that committee would be a national misfortune, and a failure on the part of the State of Massachusetts to continue it would be a calamity which would involve immense loss to the people of that State and of the entire country.

Resolved, That we have full confidence in the ability of the officers now in charge of the work of this commission, as evidenced by the report recently issued, which contains not only matter of extreme importance to the economic entomologist, but of the highest value to the farmer and fruit grower.

While the gypsy moth has not spread over the State at large, all reports to the contrary notwithstanding, it has, nevertheless, become so thoroughly established in its present definitely bounded district in the eastern part of this Commonwealth that it will be no slight task to exterminate it or even hold it in check. The State can adopt one of three courses: —

First. It can continue the policy of extermination, which would require large appropriations for a term of years.

Second. It can change the law, which now requires the committee to work for extermination, and adopt the policy of holding the insect in check. This would require a perpetual annual appropriation.

Third. It can abandon the work entirely. This would leave it for the cities, towns and individuals to deal with the pest.

It is for the Legislature to decide which will be the best and wisest policy for this Commonwealth. If the first course is adopted, there will be required an appropriation of not less than $200,000 a year for a term of not less than five years, and then an appropriation of not less than $100,000 a year for a term of not less than five years. After this an appropriation of perhaps $15,000 a year for a period of five years will be required. The sum total of all these appropriations for fifteen years is $1,575,000, or an average of $105,000 a year. A man with taxable property to the amount of $5,000, which is a little more than the average value of the farms in this State, would have to pay for the support of this work an average annual tax of 21 cents and 7 mills, and this would amount in the fifteen years to $3.25.

If the Legislature should see fit to adopt the second course, namely, that of mere restriction, it would be necessary to appropriate each year to the end of time a sum of money sufficient to prevent the insect from spreading and also from causing serious damage in the infested region. Those who are most familiar with this insect and the difficulty in destroying it estimate the cost of holding it in check at a much higher figure than some who have little or no practical knowledge of the matter. The cost has been variously conjectured and estimated at from $25,000 to $100,000 annually. My own opinion is that the latter sum would be required even in the present infested region; and, if the insect should escape and spread elsewhere, as it would probably do in time with the cessation of exterminative methods, a still larger sum would be necessary. If, however, adopting the average non-scientific view, we assume that only $50,000 annually be required to hold this insect in check, I leave it for those who believe that it is the wisest policy for the State to adopt this course to estimate what the annual appropriations of $50,000 would amount to from now to the end of time. If, however, we estimate the cost for a period of forty years, or from the time a man might take charge of a farm worth, say, $5,000, till the time he gives up the work, assuming the taxable property and rate of taxation to remain uniformly as at present, this man would have to pay, under this proposed restrictive method, an annual tax of 10 cents and 6 mills, which in forty years would amount to $4.24.

If, however, the third course, that of abandoning the work entirely, be adopted, the gypsy moth will surely spread not only over this Commonwealth but over the entire country. We must bear in mind that this insect feeds on nearly all plants of value that grow in this State, and is capable of greatly injuring or even destroying them. In the report of this committee issued in January, 1894, page 10, it was stated that "A conservative estimate made by Professor Fernald places the probable annual damage which this insect would do in Massachusetts alone, if allowed to spread, at $1,000,000." I have published elsewhere an estimate from the most carefully obtained data, that the cost of applying Paris green to potatoes to protect them from the ravages of

the Colorado potato beetles in this State alone amounts to $76,000 annually, — a sum equal to about one twenty-fifth of the value of the crop; and this has continued for many years, with every prospect that it will go on indefinitely. If, therefore, it costs one twenty-fifth of the value of the potato crop to apply an insecticide to protect it from the ravages of the Colorado potato beetle, who can deny that it will cost quite as large a proportion of the value of all the vegetable products of the farms, orchards, gardens and forests, which the gypsy moth will attack, to protect them from the ravages of this omnivorous pest? The value of these products in this State for the year 1885, as given in the State census, is $26,497,202, and one twenty-fifth of this sum is more than $1,000,000. It should be remembered that the cost of applying an insecticide to a low-growing plant like the potato is far less than would be that of its application to fruit and forest trees or grass and grain fields. In these estimates no account has been taken of ornamental trees and shrubs in this Commonwealth, for the reason that I have no means of learning the number or value of these. Their estimated value would depend largely upon their location. Those in city parks have a far greater value than those along the sides of country roads. Professor Lintner, State entomologist of New York, informs me that the Saratoga elms are insured at $500 each.

If the work of exterminating the gypsy moth should be abandoned by the State, this insect, already infesting some of the metropolitan parks, would surely spread not only to all of the parks belonging to this system but to all of those in the metropolitan region. In this case one of two things would follow: either the trees and shrubs of all the parks of the region would be abandoned to these voracious insects, to be stripped of their foliage, leaving them as bare and unsightly as in winter: or else there would be a perpetual war against them by park commissioners.

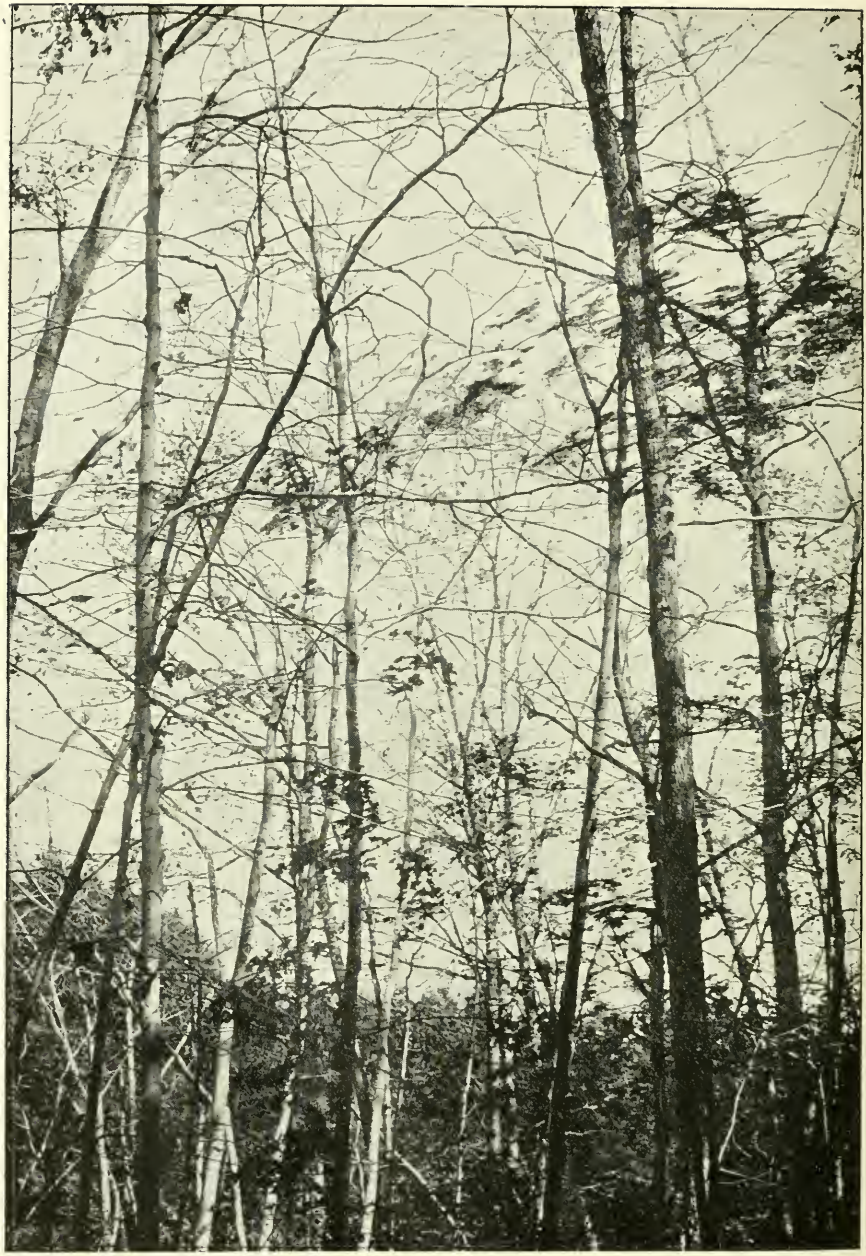
I have no data from which to estimate what the cost of such work would be, but even a superficial survey of the problem would very quickly convince one that it would be enormous. If every tree and shrub in the parks of the entire metropolitan system must be sprayed with an insecticide

during the time these insects are in the caterpillar stage, all the trees burlapped during the same time and the caterpillars gathered under them destroyed daily, we can see at once, without making a closer estimate, that the annual expense to cities and towns in the metropolitan district, one-half of which would have to be paid by the city of Boston alone, would be far greater than would be the case if the policy of extermination should be pursued.

From the facts and figures given above it will be readily seen that the policy of extermination, with the full amounts called for each year by the committee, is the wisest and most economical course that can possibly be pursued; and that the policy of merely holding the insect in check will inevitably end in the abandonment of the work by the State, and the expense of destroying this insect will fall upon every land owner, every householder, if he has any trees or shrubs on his premises, and even on every tax payer, who will have to pay his part towards the expense of fighting this insect in the public parks and grounds of the city or town in which he resides.

Respectfully submitted,

C. H. FERNALD.



A view showing forest trees stripped by the Gypsy Moth.
From a photograph taken in Medford, July 10, 1896, in the Middlesex Fells Reservation, Metropolitan Park System.

Field Director's Report.

To the Committee on the Gypsy Moth.

Gentlemen: — In the first three months of 1896, much good work was done during favorable weather, with the limited force at my command. The eggs of the moth were treated where they were found above the "snow line" on trees and other objects. Dead or dying trees in infested localities were cut and burned, when other work could not be done to advantage. When the snow was not too deep, the undergrowth was cleared from infested places in the woodland. The cavities in orchard trees were filled or covered. Loose bark and dead limbs were removed where the necessities of the work demanded, and the infested localities were put in a good defensive condition and prepared for the summer's work, so far as this could be done by the number of men that could be employed with the remainder of the appropriation of 1895. Very little work was done during storms, or when the snow lay deep upon the ground.

The delay in making the appropriation rendered impossible the carrying out of our plans for the work of the season. A few colonies were known in the outer towns where the moth had been nearly exterminated. It had been planned to enter these colonies as soon as the condition of the weather should permit in the spring, and to clear them up and do such work as would ensure the complete extermination of the moth in them during the season of 1896. Much of this work had to be abandoned. This in some cases postponed the extermination of the moth there to another year.

When it was seen that there would be great delay in

making an appropriation for the year's work, the remainder of the appropriation of 1895 was used as far as it would go in some of the badly infested localities, by destroying the eggs of the moth there and thus preventing any outbreak of caterpillars which might otherwise occur in the spring and summer, should the appropriation be so long delayed as to prevent any further work being done. Most of the field work was discontinued in March, and nearly all the men were discharged for lack of money to pay their wages.

When the emergency appropriation of $10,000 became available, April 28, it was applied in destroying the eggs on the trees in the worst infested localities, and in burning over the ground to destroy the scattered eggs of the moth in colonies where this work was deemed most necessary. The work was begun at once in the outer towns. But the caterpillars were then already beginning to hatch out. Before the burning had progressed far toward the centre, they were going up the trees. For this reason the burning ceased to be effective and was discontinued. The lapse of this work was seriously felt later.

All through the month of May the caterpillars were hatching out and spreading abroad from those worst infested localities in the central towns, where, on account of the delay of the appropriation, little or no winter work had been done. The weather of the two previous years had been particularly favorable for a great increase of the moth, and many forebodings were felt as to what might result from the enforced delay. The season of 1896 also presented favorable conditions for the multiplication of the moth, and the worst fears were partly realized in the stripping and death of trees in the woodlands, and in the spreading of the caterpillars therefrom over territory in the central towns which had been previously cleared at great labor and expense.

Some badly infested localities in the central towns had been carefully treated during the fall and winter, everything possible but the burning having then been done. This it was intended to do in the spring, as, the leaves having fallen from the trees during the fall and winter, a ground fire would then be most effective. In some of these colonies where the burning was not done the scattered eggs on the ground

among the dead leaves produced a sufficient number of caterpillars to strip the foliage entirely from the trees in the centre of each colony, so that all the labor of the season of 1895 served only to prevent the increase of the colonies, and failed to contribute to the progress of extermination. The number of the moths remained about the same, and they did quite as much injury in these colonies in 1896 as in 1895.

When in June the reduced appropriation for the season's work became available, there was no time to do more than put on the burlap in the outer towns before the caterpillars began to cluster beneath it. In many of the colonies where the eggs had hatched in April and May, and the caterpillars had scattered so as to extend the limits of the colonies and increase the number of infested trees, it became necessary to put on a much larger number of burlaps than last year. After June 20 no time remained for putting on burlaps, for it required all hands to properly attend those already on, otherwise, those put on would not have accomplished their object. Therefore, for lack of time and means no burlaps were put on the trees in the central towns excepting in Everett and on a few estates elsewhere, mostly where the property owners attended them. The defoliation and serious injury and even death of many trees which occurred during the summer might have been prevented by burlapping these trees and killing the caterpillars, had the appropriation been made in season.

Successful Spraying.

The results reached in 1895 with arsenate of lead suggested a trial with this insecticide on a larger scale during 1896. It was used on fruit, shade and forest trees, at a strength of twenty pounds to one hundred and fifty gallons of water, with glucose added. In one locality in the Middlesex Fells the trees had been entirely defoliated during part of the summer of 1895. This place was chosen for experimental spraying. No work was done in this colony during the winter of 1895–96, and the eggs therefore hatched in the spring. The colony was situated in a grove of young trees, mostly oaks, averaging some thirty feet in height. The trees on several acres were sprayed. At the time of spraying, although the

caterpillars were large and numerous and had destroyed much of the foliage before this work was begun, the insecticide was very effective, and the result at the close of the season was that the eggs deposited, as compared with those deposited the previous season, were as one (or less than one) to one hundred. Most of the egg-clusters were small, containing few eggs. This indicated a lack of vitality and development in the parent moths. Similar results were obtained in other localities. Little injury was done to the foliage by spraying, and the insecticide remained on the leaves throughout the season. Our experiments with other new insecticide mixtures give promise of equally good or better results.

While the spraying was in operation, improvements were made in the apparatus. A relief valve was attached to each pump, to regulate the pressure, thus saving labor in pumping, as well as doing away with unnecessary strain on the hose and couplings. Experiments have also been made with intent to improve the effectiveness of the pumps, and to save labor by using horse-power, steam power or compressed air. We are now directing efforts to invent and improve machinery by which both the cost and labor of spraying large trees may be reduced, and by which spraying may be made more effective. Experiments in improving the burning machinery are also in progress.

The Fall Work.

When the burlapping season was over and the eggs of the moth were deposited, most of the force was concentrated in badly infested localities, where the men were engaged in destroying the eggs of the moth until most of the foliage had fallen from the deciduous trees. Then the larger part of the force was sent into the outer towns, and used in inspecting those portions of such towns which stood most in need of an examination, or in working for the extermination of the moth in those colonies where the moth had not already been exterminated. When the snow came most of the men were again concentrated in the badly infested localities in the inner towns, where everything was done that could be done with the small balance of the appropriation then remaining.

The Condition of the Infested Region.

The condition of the infested territory is now better known than ever before. Because of inadequate appropriations, it has been impossible in any one year to inspect thoroughly the entire territory; therefore no detailed report of the condition of the infested towns has ever been published. The present report may be considered as approximately accurate, for the appropriation of $150,000, made in 1895, although not providing for all the work necessary, made possible a thorough inspection of nearly all the towns in the infested region during that year and the early part of 1896. The outer tier of towns in the infested region has been looked over far more carefully within the past two years than ever before. These towns were nearly all given a tree-by-tree inspection in 1895, or in the winter of 1895–96, and most of those which did not then have a thorough inspection have been inspected during the fall of 1896.

Beverly.

Beverly is the easternmost place which has been found infested. Several colonies were found in 1891 and in 1892, and one was found in 1894. No moths have been found in the city during the past year, although the localities previously infested have been carefully looked after, and the greater part of that portion of the city which has been most exposed to infestation has been carefully searched.

Salem.

Many colonies of the moth were found scattered over the main streets and roads of Salem in the fall of 1891. A more extended inspection, later, showed that there were also numerous colonies in Salem Great Pastures and a few in the woods. Nearly all the colonies that have been found near the centre of population have been exterminated, one of the worst being at Harmony Grove Cemetery. As much as was feasible with the means provided has been done to exterminate the colonies found in the pastures. In many cases this work has been a success, in others the lack of money

has resulted in a cessation of the work and a consequent failure to exterminate. The woodland colonies have been carefully treated. Most of the known colonies in Salem have been thoroughly examined during the present year. Salem is now in far better condition as regards the gypsy moth than in former years, but some colonies in the pastures should be burned over before the eggs hatch in the spring.

Marblehead.

Marblehead was found infested in 1891, and several colonies have been found there since. Only two caterpillars were found in the town in 1895. A careful inspection made during the fall of 1896 has shown one small colony in the south-eastern portion of the town, near Swampscott, and two egg-clusters near the centre. The work of this winter ought to exterminate the moth from Marblehead, but it must be carefully watched, as it adjoins other infested towns.

Swampscott.

In the summer of 1891 the gypsy moths swarmed in certain parts of Swampscott. They were found in small colonies along the roads, and had penetrated into the woods, where the largest colonies were found. The largest colony in the town and one of the worst in the infested region has been entirely cleared during the past five years, and no moths are now found there. The colony covered an area of about one hundred acres, a large part of which is woodland. There is a smaller colony also in the woodland which needs attention. Outside of this, there were three localities in which the moths were found in the fall inspection. These have been examined and the eggs destroyed. Most of the town has been thoroughly inspected during 1896.

Nahant.

Nahant has also been carefully gone over this year, and no moths have been found there. In past seasons small colonies of the moth have been exterminated in this town.

Winthrop.

Winthrop was found to be generally infested in 1891 and 1892. It has shown a continual improvement from year to year, and during the past autumn has been carefully inspected. Only three small egg-clusters were found.

Boston.

No gypsy moths have ever been found in the business part of the city. There is very little sustenance for leaf-feeders there, except on occasional street trees and in the parks. In the residential portion, however, many colonies of the moth have been found. That part of East Boston on Breed's Island known as Orient Heights was found badly infested in 1891, but from year to year there has been a steady improvement in its condition. With the exception of one colony, the moths appear to be exterminated there. The major part of East Boston was not so badly infested, and at present only one colony is known there. The only remaining colony known in South Boston has been carefully gone over the present year, and appears to be cleared. No moths have been found in the south end of Boston since 1895. The greatest swarm found in Boston was in the Dorchester district, one locality there yielding eighteen bushels of caterpillars in a short time. This district is now nearly free from the moth. Only one caterpillar has been found this year in the Roxbury district, which was considerably infested in 1894. In 1893 an old colony was found in Franklin Park, which, on account of the nature of the ground, was very difficult to exterminate. No moths have been found in the park during the present year. This locality, however, should be carefully watched.

Brighton was found to be infested in 1891. All of the widely dispersed colonies in this district now appear to be exterminated. No moths have been found in Charlestown in 1896.

A search of Boston was made in 1895, but no careful inspection of the whole city and its suburbs has been attempted

in 1896, for the means provided were not sufficient to do this and attend to other work which was more pressing.

Brookline.

Two colonies of the moth were found in 1896 in Brookline. A thorough inspection of the town is now in progress. So far, no moths have been found outside of these two colonies. These colonies were of several years' growth, and would have been found before had means been provided from year to year to inspect thoroughly all the outer towns. On account of the nature of the ground and the fact that the moths were first found late in the season, it is improbable that these colonies have been exterminated.

Watertown.

Several moth colonies were found in Watertown in 1891 and in 1892, and more were found later. Some of them were so situated as to render extermination extremely difficult. Much careful work has been done in these colonies. Only two places were found infested in this town in 1896. One is an extension of a Cambridge colony, situated near the Watertown line; the other, where only two caterpillars were found, is also in the eastern part of the town.

Waltham.

In only one colony in Waltham have any moths been found in 1896, all the old colonies having been exterminated previous to 1895. A careful search of the town in that year revealed one colony in the woods, which has since been carefully watched, burlapped and treated in such a way that, if it is not already exterminated, it should be by the work of another summer.

Lexington.

The greater portion of Lexington appears to be cleared, although the moth formerly existed there in many colonies scattered over the town. There are two colonies in the woodland in the northern part of the town, in which nearly everything possible has already been done to destroy all forms of the moth and to put the colonies in a condition for

the most careful work another year. If any caterpillars appear in these colonies when the eggs hatch in the spring, there will be little difficulty in destroying them all at that time. But few caterpillars have been found during the summer in East Lexington village, where a large and difficult colony was formerly located. The eastern corner of Lexington extends into one of the badly infested spots in the woodland, of which reports have been previously made. There were many trees infested in some of the woodland colonies this year. Much work, however, was done there, and these colonies all now appear to be in good condition. If sufficient work can be done there during this winter and in the early spring, nothing is to be feared from them.

Burlington.

The only colony in Burlington in which the moth was found in considerable numbers in 1896 was discovered in 1895 in the woodland. This colony has been carefully attended and watched during the summer, the undergrowth cleared out in the fall, and everything done to destroy the moth and put the locality in the best possible condition for another thorough inspection in 1897. The northern part of the town needs a tree-by-tree inspection.

Woburn.

Woburn was carefully examined in 1895. All the known colonies have been watched and worked over, and no moths are now known to exist in the town except in the southwestern portion, near the Winchester-Lexington boundary, where more work is needed. In this region the large and dangerous colony reported to the Legislature last year has been annihilated by fire.

Reading.

No moths have been found in Reading for the past two years. All the known colonies appear to have been stamped out. They have been carefully watched. An inspection of the town is now going on. The southern and central portions, contiguous to other infested towns, have now been examined.

Lynnfield.

In all the widely scattered colonies in Lynnfield, known before 1894, the moths were exterminated in that year or previously. A thorough examination of the southern part of the town in 1895 revealed several colonies in the woodland. Some of these were extensions of Saugus colonies. Others had existed in the woodland for several years, but there had been no woodland inspection, except along roads and paths, on account of lack of money. These wood colonies have already been nearly exterminated. They have all been carefully treated, the brush has been cut out and burned, and they have been burlapped for two years. In some of them no moths have been found this year, in others only a few have been found. A search of all the woodland in the town is now in progress. In this search only one small colony has been found thus far outside of those heretofore known. The situation of the town, the extent of its woodland and its popularity as a place for outings and picnics (potent factors in the distribution of the moth) may be named as reasons why it should be carefully watched.

Peabody.

Nearly all the moth colonies which were found scattered over Peabody, in 1891 and since, have been exterminated. Only three are now known. One is a large woodland colony, which it may take some time yet to exterminate.

Danvers.

Only two colonies of the moth have ever been found in Danvers. One of these was on the Salem line; the other on the Beverly line, extending over into and mostly in Beverly. These have both been exterminated.

Lynn.

Lynn was found infested in 1891, and the moth colonies were generally scattered over the city. At one time there were over twelve hundred estates infested, mostly in and about the centre of population. The condition of the city

has been improving of late years until 1896, when during the fall inspection of the known colonies eggs have been found on only one estate of the twelve hundred.

For several years it has been known that the gypsy moth has obtained a foothold in the public park known as the "Lynn Woods." This woodland has been inspected from time to time, but it should have, as soon as possible, a more thorough and careful inspection than the resources provided have previously allowed. During June of the present year a colony was found by an inspector, where the caterpillars had become so numerous as to strip the leaves from the trees and all vegetation over a small area. It is probable that there may be a repetition of this occurrence in other portions of the woodland, unless a careful and thorough inspection of the whole tract is made before the eggs hatch in the spring. The known colonies in the woods have all been carefully looked after, so that there is no danger of serious injury resulting to the park from them. If means are provided, the entire wood can be freed from the moth in a comparatively short time.

Wakefield.

Wakefield was found generally infested in 1891 and in 1892. Colonies were scattered about over the inhabited part of the town, and also in the woods. The condition of the town has been greatly improved from year to year, until at the present time only five colonies are known there, and in these only a very few moths have been found this year.

Stoneham.

In 1891 the central part of Stoneham was found to be more or less infested by the moths, and a later inspection showed that the woodland of the south-eastern part, adjoining Melrose, was also more or less infested, and that colonies were scattered through the northern end of the town. The condition there and in the central part of the town has been improved from year to year, and in the northern part the moths appear to have been exterminated. The moths have been found in only two localities in the centre in 1896.

The greatest danger of an increase and spread of the moth lies now in the Middlesex Fells region, adjoining Medford and Melrose. Careful and thorough work should be done there as soon as possible.

Winchester.

The moths were early found to be scattered throughout the Winchester village, and a later inspection showed that they had penetrated into the woods, not only in the south-eastern section, near the Middlesex Fells, but also in the western portion of the town, lying near Woburn and Lexington and north of western Arlington. This woodland is a portion of one of the badly infested wooded localities reported a year ago to the Legislature, with an urgent recommendation that sufficient money be appropriated to make it possible to prosecute actively the work of extermination therein. Careful work has been done in the western Winchester woods, with the result that very few moths are now found there. The work should be followed up during the winter by such cutting and burning as is necessary and can be done to advantage, and the remaining eggs should be destroyed before the coming spring. There has been a great improvement in the condition of Winchester the past year, and little has been found in the centre of the town during the past two years, although several bad colonies were formerly known there.

Arlington.

In 1891 a few of the worst infested localities in the region were found in Arlington, the woodland being infested, as as well as the open and cultivated land. The moths were found scattered throughout the town. Since that time they have been almost entirely cleared from the eastern part, but in the woodland adjoining Lexington and Winchester there remains considerable work to be done. An advance, however, has been made there from year to year.

Belmont.

Belmont was one of the towns found infested by the first Gypsy Moth Commission in 1890. The first work done un-

der the second commission was to enter and inspect a portion of the town and to destroy what egg-clusters were found. Many colonies were immediately located, most of them of several years' standing. The inspection of the town which followed showed that the moths were not only distributed along the roads and on the farms, but also in the woods. Handicapped by insufficient means, we have found it impossible to do all the work required in some of the woodland colonies, but most of them are in good condition. Many of the Belmont colonies have been exterminated. There are still several colonies in the town which need immediate attention.

Cambridge.

One large colony was found in Cambridge in 1890, which was so situated as to facilitate the distribution of the moth over the city. The search of the city made in 1891 showed that the moths had been scattered over most of the western portion, as well as all about Harvard Square. A few colonies have been found in Cambridgeport. The work has resulted in a gradual improvement in the condition of the city, so that now the moths have been exterminated from most of the colonies originally known. During the past year scattered caterpillars have been found, particularly in the western part of the city. Cambridge should have a thorough inspection at once, for by careful work the moths there can soon be exterminated.

Somerville.

In 1891 the moths were found scattered in colonies throughout the greater portion of Somerville. They were in considerable numbers in West Somerville. There has been a steady improvement in the condition of the city. All the known colonies have been carefully attended in 1896, and much work has been done in covering holes in trees in infested localities and preparing them for another season's work. The moth has been exterminated in nearly all the known colonies.

Chelsea.

Chelsea was found infested by the first commission in 1890. There were some badly infested localities, and the moth colo-

nies were found scattered generally about the city in 1891. Most of the colonies in Chelsea have been exterminated within the last three years. The city has been entirely inspected during the fall, and only a very few egg-clusters have been found there.

Revere.

The first inspection of Revere, in 1891, showed that the moths were in all parts of the town except upon the salt marsh, where none were found. The work of the past three years in Revere has been quite effective, and only one egg-cluster has been found there in the last inspection.

Saugus.

In the inspection of 1891 colonies of the moth were found in Saugus along the principal roads leading through the town from Malden, Melrose and Revere to Lynn; and many other colonies were found, not only in the village, but in the farming section of the town. Careful inspection of the woods was not made until later. The inspection of the woodlands in Saugus and other central towns was always more or less incomplete, on account of inadequate resources; but colonies were found in the woodlands during 1893, 1894 and 1895, showing that these woodlands were more or less infested, and in some cases the colonies were quite large. For lack of sufficient means we have not been able to do all the work that was required in these colonies, and, as a consequence, although a great deal of time has been expended on them and they have been partially held in check, they have increased and extended their limits, so that they now not only threaten to extend still farther into the Saugus woods, but to reinfest Lynn, Salem, Swampscott and other places where the moth is now nearly exterminated. If the work of extermination is to be continued with any prospect of success, it is an absolute necessity that the eggs in this woodland be destroyed before the caterpillars hatch out in the spring. This it will be impossible to do without an immediate and adequate appropriation.

Melrose.

In 1891 Melrose was found to be considerably infested. Many bad colonies were found then and later in the villages and woodlands. At the present time all the northern part of the town has been carefully gone over, and very few moths have been found. A large amount of work remains to be done in the southern portion, especially in the woodlands, and much work might profitably be done there during the present winter and the spring of 1897. Careful inspection now begun should be continued and finished before the eggs hatch in the spring.

Malden.

The western portion of Malden, being contiguous to that portion of Medford where the moth was first introduced, early became infested, and Edgeworth in 1891 was literally overrun by the caterpillars. Much careful work was then done in destroying egg-clusters and caterpillars, and this has been followed up year by year sufficiently to hold the moth in check throughout the entire city. Very little injury to the foliage has been done since 1891, except in a few cases. During the present year there was an outbreak in the southern part of the city, near the city pumping station, where the trees on about half an acre were more or less defoliated. While the moths have been held in check in Malden, even in that portion of the city contained in the woodland of the Middlesex Fells, they cannot be said to be exterminated anywhere; for, as the city is generally infested, any colony cleared is likely to become reinfested. Malden is in such a condition, however, that, were sufficient means provided at once to clear this and the neighboring towns, the moths could be almost entirely exterminated from the city in one year's time.

Everett.

The north-western portion of Everett, which is contiguous to Medford and Malden, was badly infested by the moth in 1891, and moth colonies were scattered generally over the city. The work in the city in 1891 greatly improved its

condition, which has since varied from time to time, according to the amount of work that could be done there. In 1894 Everett was in very fair condition; but in 1895, owing to the pressure of work elsewhere, comparatively little work was done there, and the moths increased rapidly. During the past summer Everett has been burlapped, the burlaps carefully attended and the infested localities examined during the fall. More caterpillars were taken there than in any other city or town, and it is now in much better condition than in 1895.

Medford.

Medford, the original home of the gypsy moth in this country, was found very badly infested from the first, and much work was done there in the early part of 1891. During the winter of 1891–92 a great deal of careful work was done in the city, and everything possible with the resources provided has been done there since. No burlap was put on in Medford in 1896, on account of the lateness of the appropriation; but the work of 1895 was so well done that only here and there in the centres of population were the moths troublesome in 1896. They have increased greatly, however, in the Medford woods within two years. This tract contains a large part of the Middlesex Fells reservation and other woodlands. This woodland centre has been necessarily more or less neglected, owing to lack of means year by year to attend properly to all the woodland in the infested territory. During the past two years several swarms of the moth have developed in the Medford woods, while many of the older colonies have increased so rapidly as to menace all the surrounding country. In 1896 many trees were stripped in two localities on the borders of the metropolitan park reservation. Most of the men working in that section of the infested region were concentrated in these woods during the first of the autumn before the leaves had fallen from the trees, and again in December, when the snow fall made the inspection of outer towns and careful cleaning work there unprofitable. During the winter of 1896-97 the work should be pushed to the utmost in these woods, otherwise there is danger that considerable injury may be done in the metro-

politan park reservation next summer, and that the moths may be scattered abroad by means of vehicles driving through the many roads which have been recently opened by the Metropolitan Park Commission.

A Summary of the Present Condition of the Infested Region.

An arbitrary line can now be drawn, enclosing the region most infested, which will leave outside of it and surrounding the centre about two-thirds of the region formerly known as infested. This outer region is nearly, if not entirely, cleared of the moth. If sufficient resources are promptly provided another year, I believe the moth can be cleared from all this outer region in a year's time. In the central region there are now only two large centres badly infested in the woodland, in place of three of about one thousand acres each which were reported to the Legislature on Jan. 1, 1896. The tract, comprising the woods of south-western Woburn, eastern Lexington and western Winchester, is now in much better condition than last year. This gain is offset by the fact that the great tracts of woodland in Medford and Saugus are now in a worse condition than ever before, though all has been done there that could be done with the delayed and reduced appropriation. This unfavorable condition of affairs requires a word of explanation.

When the work of extermination was begun by the Board of Agriculture, in 1891, there were many infested localities in the woodland in the outer towns. These colonies were particularly dangerous as moth-distributing centres, both on account of their situation near the borders of the infested region and on lines of traffic and travel to non-infested towns, and because of the character and extent of the woodland in which they were situated. In 1891 and until within two years some of these outer colonies were much more infested than those in the central woodlands. Attention therefore had first to be given to preventing the moths in these colonies from occupying a larger area in these remote woodlands, from which it would be difficult to exterminate them. Furthermore, the work of exterminating these

colonies in the outer towns had to be done, if the spread of the moth into towns outside the infested region was to be prevented. But, while the work has been so well done in these outer woodland colonies that the moth has been exterminated from most of them, it has been impossible, with the means at hand, to provide at the same time for the extermination of the moth in the colonies in the inner towns. It has been simply a case of choosing the greater of two evils to combat. The dangers of this enforced neglect have been realized, and the steady increase of the moth in the central woodlands has been known, and, as you are aware, has been repeatedly pointed out.

While some of the colonies in the outer towns were at first much to be feared as centres of moth dissemination, this danger has now been largely eliminated by the success of the work of extermination in those towns. Yet a new danger of distribution now overshadows all others. The facilities for the distribution of the moth from the central woodlands have greatly increased within the last six years, or since the work of exterminating the gypsy moth was begun. Streets have been cut through many of them, and building begun. The Metropolitan Park Commission has opened driveways and built boulevards, all of which form a network through the Middlesex Fells region; and people from all the region round-about drive over these roads and boulevards during the summer months, when the caterpillars are spinning down from the trees. Electric car lines have been opened along roads through the woods, connecting the eastern cities with the central towns and cities, one line going as far as Lowell.

There are now in the woods of these central towns probably one million egg-clusters; and, if by any delay of the appropriation for the work of 1897, these egg-clusters are allowed to hatch, they will probably produce from one hundred million to five hundred million caterpillars. We have, therefore, good grounds to fear that, should the caterpillars be allowed to hatch out in the spring, they will be spread abroad, reinfesting those towns already cleared or nearly so, and necessitating much of the work of the past five years to be done over again. This great danger can be averted

and the moth stamped out in these woodlands only by the immediate provision of ample means, which will insure the destruction of the eggs before May 1, 1897.

The condition of the towns which are or have been infested may be quickly seen by a glance at the following list. Brookline is not included in this list, as the first inspection of this place is not yet finished.

Places formerly infested, not found infested in 1896. — Beverly, Charlestown, Danvers, Nahant, Reading.

Places in which only One Locality has been found infested in 1896. — Roxbury, South Boston.

Other places in which the Moth appears to be nearly exterminated. — Brighton, Burlington, Chelsea, Marblehead, Somerville, Swampscott, Wakefield, Waltham, Watertown, Winthrop.

Places in which the Moth is now found only in Limited Areas. — Boston, East Boston, Lexington, Lynn, Lynnfield, Peabody.

Places Large Portions of which have been cleared from the Moth. — Cambridge, Revere, Salem, Saugus, Stoneham.

Places more or less generally infested. — Arlington, Belmont, Everett, Malden, Medford, Winchester.

Number of Employees in 1896.

The figures given below do not fully represent the number of employees enrolled on the pay roll, which at the height of the season considerably exceeded three hundred, but give the number of those actually at work each week. There are always some absentees, on account of sickness or leave of absence.

Jan. 1–Jan. 4,	141	Feb. 24–Feb. 29,	134
Jan. 6–Jan 11,	137	March 2–March 7,	135
Jan. 13–Jan. 18,	133	March 9–March 16,	136
Jan. 20–Jan. 25,	133	March 17–March 21,	48
Jan. 27–Feb. 1,	133	March 23–March 28,	65
Feb. 3 Feb. 8,	133	March 30–April 4,	134
Feb. 10 Feb. 15,	135	April 6–April 11,	136
Feb. 17 Feb. 22,	135	April 13 April 18,	135

April 20-April 25,	136	Aug. 31-Sept. 5,	234
April 27-May 2,	135	Sept. 7-Sept. 12,	221
May 4-May 9,	132	Sept. 14-Sept. 19,	209
May 11-May 16,	131	Sept. 21-Sept. 26,	193
May 18-May 23,	130	Sept. 28-Oct. 3,	177
May 25-May 30,	132	Oct. 5-Oct. 10,	174
June 1-June 6,	140	Oct. 12-Oct. 17,	179
June 8-June 13,	196	Oct. 19-Oct. 24,	173
June 15 June 20,	236	Oct. 26-Oct. 31,	175
June 22-June 27,	248	Nov. 2-Nov. 7,	173
June 29-July 4,	293	Nov. 9-Nov. 14,	171
July 6-July 11,	304	Nov. 16-Nov. 21,	141
July 13-July 18,	306	Nov. 23-Nov. 28,	135
July 20-July 25,	299	Nov. 30-Dec. 5,	132
July 27-Aug. 1,	281	Dec. 7-Dec. 12,	139
Aug. 3-Aug. 8,	271	Dec. 14-Dec. 19,	139
Aug. 10-Aug. 15,	268	Dec. 21-Dec. 26,	139
Aug. 17-Aug. 22,	253	Dec. 28-Dec. 31,	29
Aug. 24-Aug. 29,	244		

Summary of the Year's Work.

The figures given annually in the table of the number of each form of the moth destroyed are such as pertain only to the results of hand labor. These may be misleading, as it is quite probable that more moths have been destroyed by burning and spraying than by hand. Therefore, records of the hand work done each year do not accurately indicate the number of the different forms of the moth destroyed by all methods during each year. The other figures give only such results of labor as from their nature can be accurately reported and tabulated.

Some difference in the figures from year to year is due to the fact that, owing to the lack of adequate appropriations, only a part of the territory can be examined and worked over each year. Certain towns, for instance, are entirely inspected one year, and the inspection is necessarily omitted the next.

Work Done.

Trees (fruit, shade and forest): —	
Inspected,	10,718,836
Found to be infested with caterpillars, pupæ, moths or eggs,	57,723
In which cavities have been cemented or covered,	3,408

Burlapped,	567,025
Sprayed,	4,327
Trimmed,	90,820
Scraped,	929
Cut,	132,391
Acres of brushland and woodland cut and burned over,	477
Buildings: —	
Inspected,	24,764
Found to be infested,	815
Wooden fences: —	
Inspected,	43,917
Found to be infested,	1,318
Stone walls: —	
Inspected (rods),	18,997
Found to be infested,	633
Number of each form of the moth destroyed during the year by hand: —	
Caterpillars,	1,808,105
Pupæ,	441,899
Moths,	44,291
Hatched or infertile egg-clusters,	31,501
Unhatched and probably fertile egg-clusters,	884,928

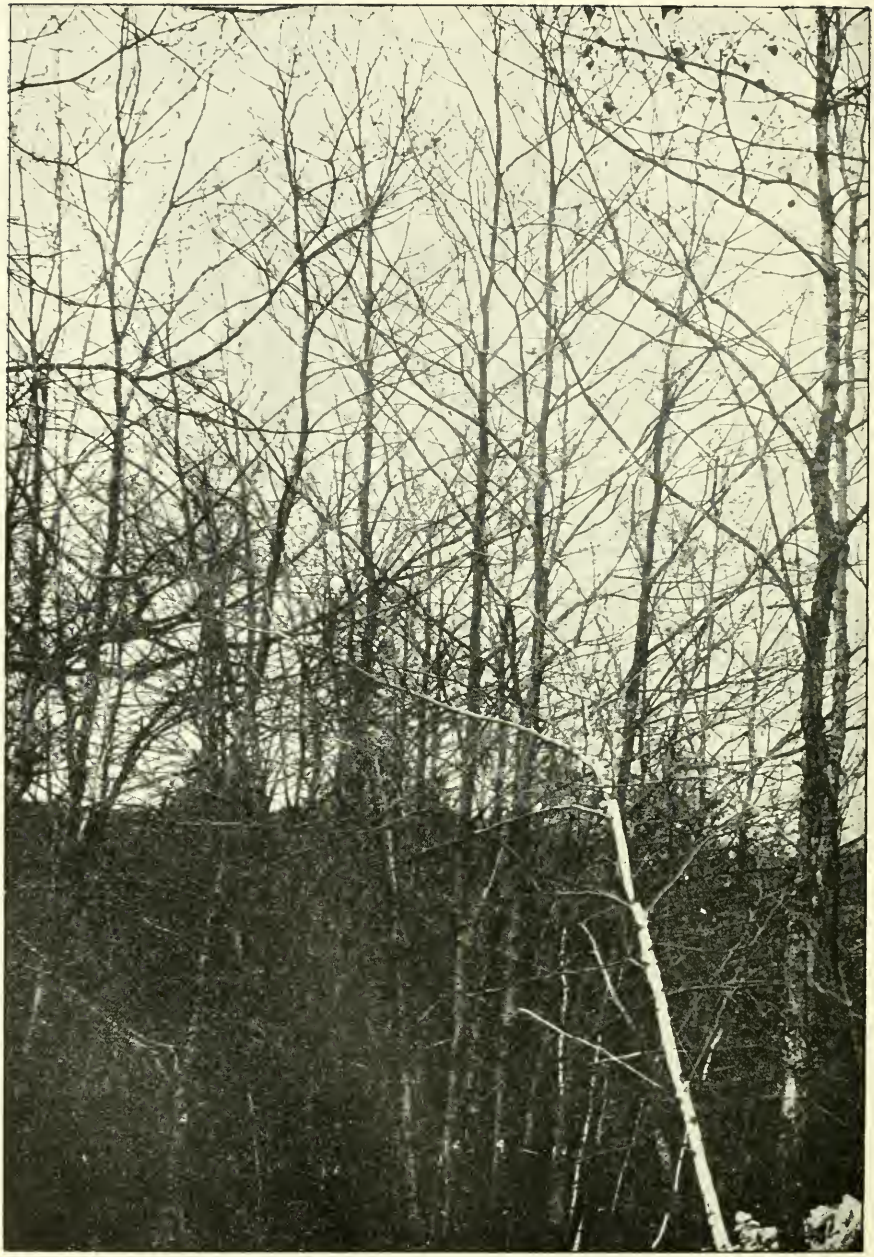
The number of trees reported as inspected is not so large as the number reported in 1895. This may be accounted for by the reduction of the appropriation and the late date at which it was granted, both of which made a thorough inspection impossible in 1896. The number of trees found infested in 1896 (57,723) is considerably less than the number found infested in 1895 (76,794). Yet the reduction in the number of infested trees in the region is more apparent than real, for, as it has been impossible to inspect thoroughly as large a portion of the field as was last year examined, there are undoubtedly many trees in the woodland of the central towns on which eggs have been laid during the summer or fall of 1896, which have not yet been examined and are therefore not recorded. There has been, however, a considerable gain, in that most of the infested places in the outer towns have been cleared; and, although the number of trees actually infested this year may possibly be as large as the number infested last year, they are mostly in fewer localities, nearer the centre of the region, so that they can be cleared at less expense than if they were scattered through the outer towns.

The number of trees sprayed in 1896 is much larger than the number sprayed in 1895, for it had been demonstrated beyond all doubt that arsenate of lead could be relied upon to destroy the moth. Also, much of the spring work having been left undone, the numbers of newly hatched caterpillars made spraying necessary in many cases where it would not have been done had the hatching been prevented. Again, much of the spraying with arsenate of lead was done in wooded localities, where there were many trees to be sprayed.

While the number of caterpillars destroyed by burlapping during 1895 was greater than the number killed in this way in 1896, the numbers of pupæ and moths destroyed in 1896 more closely approached the figures of 1895, while the number of egg-clusters destroyed in 1896 is greater than the number of those destroyed in 1895. On account of the lateness of the appropriation, it was impossible to burlap all the trees, and, on account of the reduction in the size of the appropriation, very little in the way of killing caterpillars could be done in the summer in most of the territory comprised in those towns where no burlap was put on. Therefore, more moths matured and more eggs were consequently laid in 1896 than in 1895. This accounts for the difference between the figures of the two years. Although a greater number of egg-clusters has been destroyed this year than last year, the number now existing in the woodland of the central towns is greater than the number reported destroyed.

False Alarms.

During 1896, as in former years, reports of the presence of supposed gypsy moths or of injury caused by them have been received, both from towns within the infested region and from other towns in the State; but in no such case has any evidence of the moth been found by our investigations outside the region previously known to be infested except in Brookline, which adjoins the infested region. Reports have also been received from other States. These have all been investigated, and no evidence of the gypsy moth has been found.



A view showing trees stripped by the Gypsy Moth in Saugus woods.
From a photograph taken July 10, 1896.

Towns and Cities that have been falsely reported as infested by the Gypsy Moth in 1896.

Massachusetts.	Marion,	*Maine.*
Ayer,	Milton,	Jay.
Bedford,	Newton,	
Concord,	Oakham,	*New Hampshire.*
Easton,	Quincy,	Derry.
Framingham,	Rochester,	
Foxborough,	Royalston,	*Texas.*
Grafton,	Stoughton,	Galveston.
Groton,	Tyngsborough,	
Haverhill,	Wellesley,	
Lawrence,	West Bridgewater,	*California.*
Leominster,	Weymouth,	Fresno.
Lincoln,		

The Gypsy Moth as a Forest Pest.

The gypsy moth has long been known as a destroyer of the foliage of both coniferous and deciduous trees, shrubbery and foliage plants. Instances are on record where, in European countries, it has not only destroyed the foliage and fruitage, but caused the death of trees. Several cases are cited in the somewhat voluminous report published in 1896 by the Board of Agriculture.* This report also gives many instances where trees, shrubs and garden crops in Medford, Mass., were destroyed by the caterpillars of the gypsy moth. It is also stated that vast areas of forest have been infested in Russia and other countries.

When the Board of Agriculture first began work in the woodlands of the infested district in 1891, many dead and dying trees were found in localities where defoliation had occurred for one or more years. These trees were cut and burned. It was then impossible to determine to a certainty the cause of their death. Since that time there has been no opportunity to observe the effect of the defoliation of trees for even two successive seasons until 1896. This year the delay in the appropriation allowed the moths to obtain

* "The Gypsy Moth," E. H. Forbush and C. H. Fernald. Issued by the Massachusetts State Board of Agriculture, 1896.

sufficient headway in some woodlands, which were defoliated in 1895, so that the trees were again stripped in 1896.

So far as observed, all pines which have been defoliated for even one year have died, and some which have not been entirely defoliated are dying. Where oaks have been defoliated two years in succession, a large proportion of them are now either dead or dying. In one locality in the large forest park, controlled by the Lynn municipality, and known as the "Lynn woods," where a small area of young trees, mostly oaks, was stripped in 1896, many of them are either dead or dying. In several localities in Saugus, where the trees have been stripped for two years in succession, we find the same condition. There are several other localities where trees appear to have been killed by total defoliation one season and partial defoliation the next. One of these where the greatest injury was done was in the Lexington woods. Thus we have demonstrated the fact, which has been hitherto denied by some, that defoliation by Lepidopterous insects may weaken and destroy deciduous trees.

The trees appear to die from the tops. The defoliated limbs apparently suffer from sun-burn or sun-scald, and this condition is closely followed by the attacks of bark borers, *Scolytidæ*, which still further weaken the tree. It is well known that these insects frequently follow the leaf-eaters, and they soon complete the destruction of the tree.

Judging by the foregoing observations, the danger to our forest and park reservations appears to be great. Should the insect be allowed to increase and spread, the great cost of protecting the forest growth would preclude any effort in that direction by the great majority of land owners.

Unless the work of destroying the eggs of the moth in the woodlands of Medford, Saugus and other towns is promptly provided for, much serious injury may be done, especially in the Middlesex Fells reservation, during the coming year.

Methods used in Forest Work.

It is not extremely difficult to exterminate the gypsy moth from shade or fruit trees or from open or cultivated lands. Although the danger of a distribution of the moth to a dis-

tance is not under ordinary circumstances as great in woodland centres, remote from human habitations, as it is where the moths are numerous in cultivated lands or in centres of population, the cost of exterminative work in woodlands is greater and more time is required for extermination. If woodland colonies are not "nipped in the bud," the increase of the moth and its limited distribution go steadily on, even though it be held in check by repressive measures, so that it does not do any appreciable injury. This comparatively slow but sure distribution over a large woodland area greatly increases the ultimate cost of the work of extermination. It is more economical to expend, if necessary, a thousand dollars at once in stamping out a woodland moth colony while it is confined within narrow limits, than to expend a smaller sum and allow the moth to spread (which it will do even if its increase is partially checked), so that an expenditure of thousands of dollars will be required year after year, annually increasing, to merely hold it in check.

Where a small isolated colony is found in the woods, the quickest way to dispose of it is to cut all trees and burn the underbrush and rubbish in the fall or winter. The ground should then be burned over with crude oil once or twice in the spring, about the time the young caterpillars hatch out. Within the past two seasons an experiment of this kind has been tried on a large scale on a wooded hillside, on the estate of Mr. W. H. Winning, in Woburn. The moths appeared in the summer of 1895 in numbers sufficient to strip the foliage from the trees on two tracts of an acre or more each. A careful examination of the surrounding woods showed that the moths had scattered over some fifteen acres in the immediate vicinity. The growth was largely oak and the trees were from forty to sixty feet in height. All the trees and undergrowth on an area of about ten acres were burned and on the rest the wood was cut and marketed. The leaves were raked up and burned in the fall of 1895, and in the spring of 1896 the ground was burned over.

Although the first burning in the spring swept the land so that very little remained except stumps and ashes, a few caterpillars appeared later around the edges of the burned tract and fed for a time on the sprouts which sprang up after

the fire. Here the ground was again burned over and the moth was no doubt exterminated on this tract.

As much of the forest land now infested has been reserved for water or park purposes, it has not been deemed expedient to use this method elsewhere, except in small colonies, or in sproutland where the wood is of little value. Considerable burning, however, has been done in connection with clearing waste land and in destroying the moth in certain situations where other means of destruction are of less avail.

In badly infested localities in the woodlands which are cleared to destroy the eggs, there is usually much débris on the ground in the shape of dead leaves, broken pieces of decayed branches, decayed stumps, bark, etc., on and among which the eggs of the moth have been deposited by the moths themselves, or scattered by other causes. Therefore, even if the eggs on the trees are destroyed, the task is not complete, for in such localities many scattered eggs will remain upon the ground, and, if they are unmolested until hatching time, the young caterpillars will ascend the trees, and injury, which varies according to circumstances, results. If, however, before hatching time the underbrush is cut, piled and burned, the dry leaves and other débris raked together and burned, and if afterward the ground is burned over with oil, most of the scattered eggs will be destroyed. Even then, however, some may escape the burning, and caterpillars will usually be found in the locality another season.

A more successful method is as follows: The eggs upon the trees are treated with creosote or petroleum, and thus destroyed early in the fall. The undergrowth is cut away and the dead limbs burned. The colony is then left for the winter. Just before the caterpillars hatch in the spring, the trees are banded with "Raupenleim" or some other substance which will prevent the caterpillars ascending. As they hatch out they feed on whatever may be available on the ground, and when all the eggs have done hatching, the ground is burned over with the cyclone burner. This has proved the speediest way to exterminate the moth in the woods where the trees are left standing; but examining the trees and burning over the ground are very expensive

methods. Although in open and cultivated lands the destruction of eggs is considered one of the most efficacious and practical methods of dealing with the moth, this is not the case in badly infested woodlands, where, unless fire is also used, all that can be done by egg-killing, even at a great expense, is to partially check the evil. Yet in badly infested localities all the eggs possible must be destroyed to prevent a great increase and dissemination of the caterpillars, for their expansive energy increases in proportion to their numbers.

There are two methods of coping with woodland colonies, which, under certain conditions, have proved more effectual than egg-killing. These are spraying with arsenate of lead, previously mentioned, and banding the trees with burlap. Neither of these methods alone, however, can be depended upon to exterminate, but either will dispose of most of the moths. To secure extermination either of these methods must be supplemented by others, such as egg-killing, cutting, burning, etc., as circumstances may require.

It is well known that in 1891 spraying with Paris green for the gypsy moth proved to be a partial failure, and very little spraying was thereafter done until the discovery and successful use of arsenate of lead. Spraying, however, has its disadvantages, and cannot be used over a large extent of territory with results proportionate to the expense required.

There is only about one month of the year during which the most effective spraying for the gypsy moth can be done. This period is from about the 15th of May, when the larger proportion of the caterpillars have hatched out and the foliage has reached a certain size, to about the 15th of June, when all the caterpillars have appeared, and most of them have reached an age when they will cluster under the burlap. If within this short spraying season there are two or three weeks of rainy weather, very little effective spraying can be done, as the poison will not stay on the leaves unless they are dry when it is sprayed on. Therefore, although spraying may be very effective in certain localities and in certain seasons, it cannot always be depended upon. The short season also makes necessary a great expenditure for spraying apparatus, if the work is to be carried on over a large area. Furthermore, spraying must be done by com-

petent men and carefully watched, and it is difficult to secure, for a month only, a sufficient number of workmen and foremen competent to conduct a great amount of this work.

When the caterpillars begin to cluster, burlapping may be done to advantage and it is certainly very effectual. In order that the burlaps may attract the largest number of caterpillars, it is necessary to at least remove the undergrowth and dead limbs from the ground. This should be done, whatever method is adopted, for the undergrowth facilitates the escape and distribution of the caterpillars. In order to secure extermination in the woodland colonies, the dead branches and loose bark must be removed from certain trees, cavities must be closed, and a careful search for eggs in the fall must follow burlapping or spraying. This search will then be a comparatively light task, for, if the burlaps are put on early and carefully attended, or if the trees have been successfully sprayed, comparatively few moths will be left to deposit eggs. To guard against caterpillars, resulting from possible scattered eggs, the trees must be burlapped the following year.

All these methods may be used in woodland, as circumstances require, and by a proper combination of them the best results may be secured at the least expense. To secure extermination, however, the work must be preceded and supplemented by a thorough and careful search for eggs, pupæ, moths and caterpillars in their season, and it is by this search that the final extermination of the moth in wood colonies has been secured and verified.

Birds which feed on the Gypsy Moth.

During the past few years observations which have been made on our native bird enemies of the gypsy moth have given us a list of birds all of which are more or less useful in destroying the moth in some of its forms. The list of birds observed to feed upon the moth has been increased from year to year, as the moth has appeared in different localities. Wherever the moth swarms, some birds will be found to feed upon it. When it appears in the woods, more

wood birds feed upon it; when it appears in the orchards, orchard birds will be found most useful. In the vicinity of swamps or meadows about lakes or streams some of the birds which frequent these localities are found feeding on it.

Where the moths are unusually numerous, the limited number of birds cannot keep pace with the moths' increase, and therefore can destroy only a small proportion of them; but when the moths are reduced in number by man, the birds are of great assistance in the work of extermination.

Lists of birds found feeding on the gypsy moth have been given in my annual reports from year to year. The list published in the last report is the most complete, and contains the names of thirty-eight birds.*

Beside the species contained in this list, the red-winged black-bird (*Agelaius phœniceous*, Linn.) and several species of sparrows not identified have been seen feeding on the moth. Most of the birds named in the list feed upon the caterpillars. This is rather surprising, and does not agree with the generally accepted theory that birds do not eat hairy caterpillars. Were our birds sufficiently protected, they might become numerous enough to check materially the increase of the moth. Unfortunately, however, the most useful birds are so persecuted that they are few in numbers and consequently of little assistance. In this country no birds have been seen to eat the eggs of the moth, and careful observations and experiments indicate that none of our native birds will destroy them. This must remain a serious draw-back to the usefulness of native birds, unless they learn that the eggs are good for food. We also lack the larger species of ground-frequenting birds, the unfledged young of which feed largely on insect larvæ. The prairie chicken, wild turkey and passenger pigeon have long since been exterminated from Massachusetts, and the larger wading birds are not common in the worst infested region. Although there are a few grouse and quail, they are so persecuted by gunners that they are not numerous enough to be of much assistance in destroying the caterpillars, even if they eat them at all. Although the caterpillars are exposed to the attacks of their bird enemies upon the trees, only a few birds, like the tow-

* "The Gypsy Moth," Forbush and Fernald, pages 207-208.

hee, brown thrush and some of the sparrows, seek for the moths on the ground in the woods, where they are enabled to conceal themselves and their eggs among the dead leaves. I would recommend that an attempt be made to protect and foster native birds in the Middlesex Fells reservation, and that careful observations be made of the effect of this policy on the gypsy moth and other injurious insects.

It has been suggested that European birds might be imported to destroy the eggs on the trees as well as the caterpillars upon the ground. I should not advise that this be done, in the present state of our knowledge of the subject. At a session of the Congress of the American Ornithologists' Union, held at Cambridge, Nov. 12, 1896, this suggestion was the subject of discussion. Among the members of the union are the most eminent ornithologists in the country. Dr. J. A. Allen of the American Museum of Natural History, New York, said there was very little accurate information to be obtained on the question of the introduction of birds, for no careful study had been made of the subject. As a matter of opinion, however, he believed it unwise to attempt the importation of birds for the purpose. He thought the importation of the titmice, which are said to eat the eggs of the gypsy moth in Europe, would probably result in failure.

Dr. Elliot Coues of Washington said that experience had demonstrated that the importation of animals from foreign countries had been either costly failures or costly successes. Such animals when introduced had become pests in the new country, and he was strongly opposed to any attempt at introducing birds.

Other members followed in the same strain. It seemed to be the general opinion that either the imported species would die out, or that, if it became numerous enough to be of any assistance, it might become so numerous as to prove a nuisance in some way.

Should any study of the enemies and parasites of the gypsy moth be made abroad, it would be well to investigate there the influence exerted by birds on the increase of the moth, and to observe carefully the habits of such birds as may be found to feed upon the moths' eggs. In this way we

might determine whether the usefulness of foreign birds in this respect has been exaggerated or underestimated, and form some judgment of the desirability of attempting their importation.

A species of Mongolian pheasant (*Phasianus torquatus*) has already been introduced under the auspices of the Fish and Game Commission of Massachusetts, and the chairman of the commission, Hon. E. A. Brackett, has been engaged in propagating them for a year. Many are now at liberty, and have been seen in the infested region. If they winter well, there seems to be little doubt that the introduction will be successful.

Mr. Brackett has observed that the young pheasants destroy the caterpillars of the gypsy moth, and, in fact, all insects within the enclosure in which they are confined. He has offered to place at our disposal a few of the pheasants and to furnish eggs for hatching another year, so that experiments may be made with the birds. This bird was introduced years ago into Oregon, Washington and British Columbia. It is said to do very little harm, and as the young, like the young of most land birds, are said to feed almost entirely on insects, and as the bird is protected by law, it may help to fill the gap among the enemies of injurious insects which has been made by the wanton destruction of our native gallinaceous birds.

The Co-operation of Property Owners.

During the past six years a disposition to co-operate with the agents of the State Board of Agriculture in the work of exterminating the gypsy moth has steadily increased among property owners. In some localities where the moths have done considerable damage in the past, the property owners or residents have assisted by killing caterpillars under the burlaps during the summer months, and some have assisted in other ways. Notable among these are Gen. S. C. Lawrence and Mr. Walter Wright, both of Medford; Messrs. Samuel and Richard Hawkes of Saugus; and Mr. Barthold Schlesinger of Brookline. General Lawrence, who owns a sixty-acre farm and a large tract of woodland near the Middlesex Fells

reservation, has year after year employed men in trimming out the undergrowth in the infested woods and destroying the caterpillars by burning, burlapping and spraying. He has also destroyed a great number of eggs. During the past summer several men in his employ have been engaged on his estate in killing caterpillars under burlaps in infested woodland, and have much reduced the number of caterpillars in these localities. Mr. Walter Wright, whose estate is neither so large nor so much infested as that of General Lawrence, has treated many egg-clusters upon both his home and woodland property, and has burlapped the trees, employing a man in killing caterpillars under the burlap. Mr. Samuel Hawkes, who owns a large tract of infested woodland in Saugus, has spent much time in searching for the gypsy moth in these woodlands, and has cut some tracts of infested trees. He has also given the agents of the Board information which has been of assistance to them in their work. Mr. Schlesinger, who owns a large estate in Brookline, on which a colony of moths was found this year, has directed his gardener and the men under him to assist the agents of the Board in every way possible, and these men destroyed many of the different forms of the moth and assisted in other ways. The gentlemen who have given most assistance, as described above, are owners of large property, and are better able to protect their estates from the ravages of the moth than are most of our farmers and other owners of smaller or less valuable holdings. The poor man who rents or owns a small place has neither time nor means to check the ravages of the moth; and a farmer with an orchard, garden and many acres of woodland would better give up his home at once than spend his substance in fighting the gypsy moth.

Respectfully submitted,

E. H. FORBUSH.

APPENDIX.

Notes on Predaceous Insects which attack the Gypsy Moth.

The following papers on predaceous insects were prepared by my assistants from studies and observations which were made both in the field and in the insectary during the summer of 1896.

C. H. FERNALD.

Notes on the Life History and Habits of Certain Predaceous Heteroptera.

A. H. Kirkland, M.S., Assistant Entomologist to the Committee on the Gypsy Moth, Insects and Birds.

Podisus placidus (Uhl.).

This interesting little Hemipteron, whose predaceous habits were first recorded by Saunders,* has been repeatedly taken during the past year while feeding upon the larvæ and occasionally pupæ of the gypsy moth. In habits and in the appearance of the early stages this insect closely resembles *P. serieventris*, whose life history we have given elsewhere.† During the summer months of the past year specimens of *P. placidus* were taken on a great variety of trees and bushes, their distribution in this respect being governed by the presence or absence of the insects on which they feed. The imagoes of the fall brood hibernate and in this region make their appearance about the middle of May. At this time the males considerably outnumber the females. In common with *P. serieventris* this species is a formidable enemy of the tent caterpillar (*Clisiocampa americana*), and this latter insect generally furnishes the first food supply of the season for these bugs. *P. placidus* shows a greater proclivity for entering the webs of the tent caterpillar than does *P. serieventris*, possibly because the shape of its body renders it better able to force an entrance into the web, since the humeral processes do not project to such a degree as in the latter species.

A fortnight or more is spent in feeding before the eggs are laid, although the sexes are frequently found in coitu soon after emerging from hibernation. Egg-laying takes

* Can. Ent., Vol. 2, pp 15-95. Report Entomological Society, Ontario, 1871, p 31.
† "The Gypsy Moth," Forbush and Fernald, 1896, p. 395.

place in from three to ten days after pairing, depending upon the temperature, warm weather hastening and cold weather retarding this process. Each female deposits from two to four egg-clusters at intervals ranging from a few hours to three days.

The Egg. — The general appearance of the egg (Plate 1, Fig. 1) so closely resembles that of *P. serieventris*, both in size and markings, that the separation of the species in this stage is extremely difficult. The eggs are deposited in clusters composed of a single layer. From ten to thirty-five eggs are placed in a cluster, each egg resting on its smaller end, and connected with the adjacent eggs by means of a varnish-like cement. The form of the egg is nearly ellipsoidal, slightly tapering toward the lower end, but not as caldron-shaped as in *P. serieventris*. Length, 1 mm.; width, .8 mm. Top slightly flattened, and surrounded by a row of ten or twelve capitate spines, arranged around the margin of a circular cap. The surface of the egg is covered with minute spiny projections, not abundant at the lower end of the egg. When first laid the eggs have a pearly white color which soon changes to a deep bronze. The period of incubation extends over eight or ten days, according to the temperature. The circular cap at the top of the egg is pushed off by the young bug at the time of hatching, but usually remains attached at one point.

First Stage. — The newly hatched bug (Plate 1, Fig. 2) is 1.7 mm. in length. Form ovate. Head and thorax dark seal brown, abdomen vermilion. The head is much wider than long, closely appressed to the prothorax, and bears large compound eyes, which, from their relative size, are quite conspicuous. Antennæ four jointed, basal joint stout, nearly concealed beneath the margin of the head. Second joint cylindrical, three times as long as basal joint; third joint cylindrical, three-fourths as long as second joint; fourth joint one-half longer than second joint and considerably dilated; all the joints bear scattering hairs. The terminal joint is seal brown in color, the other joints being copper colored.

The thorax is dark brown with a faint median sulcus. The posterior margin of the meta-thorax is tinged with red. Immediately behind the posterior angles of the thorax, on each side, is a small dark-brown wedge-shaped spot, arising from the outer margin of the abdomen. Following this spot and extending on either side to the anus there is a border of semi-elliptical spots of similar color, one spot on each segment. At the anus there are three small markings of the same color. On some specimens, bordering the interior margins of the dark-brown spots, there is a faint undulating white line extending around the abdomen. On the dorsum of the abdomen, about equi-distant from each other and the posterior margins, are two transverse copper-colored spots. Between the anterior of these spots and the thorax there are two narrow transverse markings of similar color. Under surface of the abdomen reddish brown; legs of similar color, but somewhat darker. Tarsi two jointed. Beak extending to hind coxæ, of same color as legs. In this stage these insects are in general phyllophagous. The first molt takes place in about seven or eight days.

Second Stage. — (Plate 1, Fig. 3.) Length, 3 mm. General form same as in preceding stage, except that the head is quadrate and the abdomen larger in proportion to the size of the head and thorax. These latter are pitchy black in this stage. With the exception of the terminal joint, which is shorter, much darker and less dilated, the joints of the antennæ retain their relative length.

The abdomen is dark red. Marginal spots black and bordered on the inner margin with white. Behind the thorax on the dorsum of the abdomen are two large transverse dark-brown spots, which in some specimens are nearly fused together. Posterior to these spots are two smaller transverse markings of similar color. Under surface of head and thorax dark brown. Legs and beak of the same color. Abdomen same color as upper surface. In this stage the insect develops predaceous habits. The second molt takes place in about twelve days.

Third Stage. — (Plate 1, Fig. 4.) Length, 5 mm. General form of body as in preceding stage, but the head

is not quite as large in proportion to the rest of the body. Head black, eyes quite prominent. Antennæ black, basal joint stout, projecting about one-third of its length beyond the margin of the head. Second joint four times as long as basal joint, cylindrical, slightly dilated at the outer end. Third and fourth joints about two-thirds as long as second joint. Fourth joint slightly dilated, but not as much as in the preceding stage.

Thorax entirely black, margined by a distinct white or cream-white line. The color of the thorax and the white margin distinguishes the insect in this stage from the corresponding stage of *P. serieventris*. Abdomen of same color and with similar markings as in preceding stage, except that of the four dorsal spots the two middle ones are the largest, the anterior and posterior spots being narrowed transversely. Colors of under surface and legs as in preceding stage. In this stage, as well as those which follow, the insect is almost entirely predaceous.

Fourth Stage. — (Plate I, Fig. 5.) Length, 7 mm. Head, thorax, wing-pads and scutellum intense pitchy black. Joints of antennæ as in third stage; basal and second joints seal brown, third and fourth joints black. Thorax margined with white, as in preceding stage. Both the marginal and dorsal spots of the abdomen are closely appressed. Across the dark-red ground color of the abdomen fine white transverse lines connect the lateral and dorsal spots. The same variation in color observed in *P. serieventris* also occurs here, and in some specimens the white lines predominate to such an extent as to give the abdomen a light striped appearance. Under surface of body yellowish brown. On the median line near the end of the abdomen are three small, somewhat circular black spots. Femora straw colored, marked longitudinally with brown; tibiæ of same color at junction with femora, shading downward to a dark seal brown. Tarsi dark brown varying to black.

In this stage the insects feed voraciously. The fourth and last molt, in specimens under observation, took place in about twenty-two days from the preceding molt, but I

think under natural conditions the period spent in this stage would be somewhat shorter.

I have been unable to find in the literature at my disposal any description of the imago of this species, and it seems doubtful if such a description has been heretofore published. At my request Prof. P. R. Uhler has kindly prepared, for publication in this connection, the following characterization of the species: —

Podisus placidus Uhler. — (Plate 1, Fig. 6.) "Of a narrower and more oval form than *P. serieventris*, with a head somewhat tapering anteriorly, and rounded at tip instead of being truncated, and with the humeral angles rounded off and very moderately prominent. Color pale testaceous, stained with pale brown and punctate with darker brown. Head much longer than wide, depressed, remotely punctate, the edge reflexed, brown; each side of tylus is a slender brown line which is triangularly expanded on the base of the vertex; occipital margin dark brown in the middle, pale and narrowly callous each side; a pale callous line extends back from each ocellus; throat whitish testaceous; cheeks with a slender black line before each eye; eyes brown, bordered with testaceous behind; antennæ pale brown, paler at base and on the two last joints; the basal joint testaceous, very short, the second longest, third scarcely more than half the length of the second, fourth about three-fourths as long as the second, fifth a little shorter than the fourth; rostrum stout, pale testaceous, reaching upon the posterior coxæ, the apical joint narrow, about as long as the preceding one, brown. Pronotum with the sides straighter than usual, the lateral margin narrowly callous, pale ivory yellow, and with a few indented points and small teeth before the middle; the submargin with a brown line, surface with wavy, transverse pale lines between the pale brown marbling, more generally brown behind the middle; posthumeral margins slightly sinuated; anterior margin callous, having a small group of coarse punctures behind each eye; punctures sunken, brown, mostly not close together in the transverse series; posterior margin truncate. Scutellum long, bluntly rounded and margined with white at tip, punctures in short transverse series, grouped in about three spots at base. Corium slenderly bordered with pale testaceous, more broadly covered with brown at base and on the disk, the veins posteriorly yellow; membrane pale bronze. Legs minutely speckled with red, the tibiæ and tarsi a little stained with brown. Under side finely punctate, the sternum with two series

of black points. Connexivum depressed, punctate, the outer edge ivory white, callous and marked with two black points at each incisure of the segments; the upper surface yellow, with the black points more linear. Length to end of abdomen, 8½ to 10½ mm. Width of pronotum, 4⅔ to 6 mm.

"Through the kindness of many friends, I have had the opportunity to examine specimens from the provinces of Quebec, Ontario and Columbia, in British America, from nearly all of the New England States, besides Illinois, Iowa, Michigan and Colorado. The genital segment of the male is deeply excavated, and with two short processes on the middle. The tergum is often bright red, which color becomes brownish in more mature specimens. The humeral angle is usually more or less black. In some specimens there is a series of minute black dots each side of the venter, and a few obscure spots distributed over the ventral surface."

There are undoubtedly two annual broods of the insect in this locality, and it seems probable that in especially favorable seasons there may be three broods.

The nymphs and imagoes of this species fraternize with those of *P. serieventris*, although this appears to be wholly accidental, and depending upon food supply. I have found *P. placidus* feeding upon the larvæ of *Euvanessa antiopa*, *Hyphantria cunea*, *Orgyia leucostigma*, *O. definita*, *Clisiocampa americana* (previously mentioned), *C. disstria* and a small, undetermined saw-fly larva common on oaks.

One must note with regret that this decidedly beneficial little insect, which destroys so many injurious species, is preyed upon by two spiders which are common occupants of tent caterpillar webs, *Epeira strix* Hentz and *Phidippus multiformis* Em.*

Dendrocoris humeralis † (Uhl.) (Plate 2, Fig. 8).

This small Pentatomid was originally described by Prof. P. R. Uhler (Bulletin United States Geological Survey, Art. XIV., page 399) under the genus *Liotropis*. According to Montandon, this generic name is preoccupied (Uhler in litt.), and the insect should be placed in the genus *Dendrocoris*. The specimens from which the original

* These spiders were kindly identified by Mr. J. H. Emerton.

† Identified by Prof. P. R. Uhler.

description was prepared were taken in Massachusetts, New Jersey, Maryland and Colorado, and from its wide distribution and occurrence on many plants the opinion was expressed that the species was predaceous in habits. That such is the case our observations of the past two years afford ample evidence. We have repeatedly found this diminutive Hemipteron engaged in destroying tent caterpillars, and on several occasions have taken it in the act of feeding upon gypsy moth larvæ.

While as yet we have been unable to rear this species through its transformations, the dates of our captures of nymphs and imagoes lead us to the opinion that the insect is double-brooded, and doubtless hibernates in the imago state.

Description of Full-grown Nymph. — (Plate 2, Fig. 7.) Length, 5 to 6 mm. Body broad, very compact. Head somewhat sunken in prothorax, deeply cleft in front, thickly dotted with reddish brown and margined with black. A very short and very blunt spine projects laterally in front of either eye. Eyes dark brown, bordered posteriorly with sordid yellow. Prothorax thickly punctured with dark brown except at lateral margins, which are of a pale yellow color. At the humeral angles the dots are aggregated into a dark brown or black spot. Scutellum and wing-pads of the same color as prothorax, except that the outer anterior part of each wing-pad is marked with reddish yellow. Abdomen pale yellow, heavily dotted with vermilion. On the lateral margins of each abdominal segment there is a semi-elliptical black spot, which is divided by a narrow yellow band extending parallel to the margin. On the dorsum are five transverse black spots, each of the three anterior being divided transversely by a yellow line. The spot immediately behind the scutellum is quite narrow; the second and third spots are large and prominent; the fourth and fifth scarcely more than short transverse black lines.

Under surface of head and thorax amber yellow, heavily bordered with black. There is a small white spot at the base of each antenna. Abdomen of the same general color as upper surface. Antennæ dark brown throughout; first

joint stout, scarcely reaching the margin of the head; second joint over three times as long as basal joint; third and fourth joints each about one-half as long as second joint. Legs pale amber, darkening to brown on tibiæ; tarsi dark brown.

This species is widely distributed throughout the region infested by the gypsy moth, but does not occur in such numbers as do its allies in the genus *Podisus.* I have taken specimens in Medford, Malden, Saugus and Revere, while Professor Uhler records it from Andover, Lynn and Charlestown.

EUSCHISTUS POLITUS Uhl. (Plate 2, Fig. 12).

A rare member of our heteropterous fauna is a small *Euschistus*, which, previous to the past summer, had been occasionally taken under such circumstances as to give the impression that it possesses predatory habits. Specimens of the insect submitted to Prof. P. R. Uhler were considered by him to be new to science, and at my request he has very kindly prepared the following description: —

Euschistus politus. New sp. — "Pale dull fulvous, or rufo-fulvous, suboval, with the humeral angles almost rounded and very moderately prominent. Head narrow, as in *E. tristigmus* Say, deeply and finely punctate, the tylus prominent at tip and a little longer than the lateral lobes, the lateral lobes deeply sinuated, with the outer margin blackish. A black line extends from the eye to base of antennæ; antennæ (Plate 2, Fig. 13) clay yellowish; the basal joint short, hardly reaching the apex of head, marked with a few black points; second joint longer; third a little longer than the second; fourth longer, dusky at tip; fifth a little longer than the fourth, fusiform, blackish excepting at base; rostrum pale testaceous, slender, with the setæ piceous, reaching to the posterior coxæ. Pronotum much wider than long, polished, closely and finely punctate with brown; the lateral margins very slightly sinuated, smooth, ivory white; the submargins blackish; humeral angles triangularly rounded; posthumeral margins almost straight. An obsolete, callous, imperfect curved line extends between the humeral angles. Scutellum narrow and bluntly rounded at tip, where it is also slenderly margined with white; the surface is less densely punctate in small spots. Wing-covers (Plate 2, Fig. 14) closely punctate; membrane a little brownish,

the veins and numerous dots darker brown. Legs pale yellow, remotely dotted with brown. Beneath pale greenish, finely punctate, highly polished, the pleuræ with a row of fine black dots, and an extra dot outwardly; connexivum acute, the intersegmental sutures indented and marked with a black dot. Tergum black, the sutures, exteriorly, with a double black spot. Length to end of abdomen, 9 to 10 mm. Width of pronotum, $5\frac{1}{2}$ to 6 mm. A pair of these insects taken in Massachusetts have been kindly given to me by Mr. A. H. Kirkland. Other specimens have been sent to me for examination from Rhode Island, Pennsylvania and the District of Columbia. I have found it once, July 4, in a sandy pine woods district in southern Maryland. Only a few specimens have thus far been reported. It seems to be of rather uncommon occurrence."

A female of this species, confined in a small breeding cage with larvæ of *Porthetria dispar* (L.) and a number of oak leaves, deposited a cluster of thirteen eggs upon the under side of a leaf, June 21, 1896. The eggs were placed in a single layer. Very unfortunately they proved unfertile, so that I was disappointed in my anticipation of being able to carry the species through its early stages. The egg (Plate 2, Fig. 11) may be described as follows: —

Color, pearly white. Length, 1 mm.; width, .8 mm. Form, nearly cylindrical, the upper and lower ends being abruptly flattened. Around the cap at the upper end of the egg is a row of delicate, elongated, club-shaped spines. The surface of the egg is covered with small single blunt spines, between which are numerous similar spines of microscopic dimensions.

During the past summer I have been able to establish the fact that this species is predaceous upon the larvæ of the gypsy moth, thus making an addition to the list of the natural enemies of this insect. As an enemy of the gypsy moth it is of only minor importance, and from the slender structure of the beak I am led to believe that the insect is more of a plant feeder than an insect destroyer.

Diplodus luridus * (Stål).

The members of the group of insects to which this species belongs possess such marked predaceous habits that they have received the very appropriate name of "assassin bugs." The species under consideration is one of the most rapacious of our predaceous bugs, and, while occurring in but limited numbers, its great activity and almost abnormal appetite render it a formidable enemy to several forms of insect life.

On May 12, 1896, I took a nearly full-grown nymph in the act of feeding upon a partly grown tent caterpillar. An inspection of the tree in the vicinity of the web showed several other nymphs engaged in the work of destroying the caterpillars. The nymphs did not enter the webs of this caterpillar, as do some of our predaceous Pentatomids, but devoted their attentions to such larvæ as were more or less isolated and at some distance from the web. One of these nymphs was reared upon tent caterpillars until May 18, when it assumed the mature form.

Later in the season several imagoes of this species were found attacking gypsy moth larvæ, as well as those of *Clisiocampa americana*. From a female confined in a breeding cage with a male imago from June 5 to 10 I obtained June 12 a cluster of thirty-four eggs, which were laid in a compact mass (Plate 2, Fig. 1) shaped like the frustum of a cone.† The eggs were closely cemented together and to the surface on which they were deposited, and could only be separated with difficulty. The eggs (Plate 2, Fig. 2) may be described as follows: —

Length, 1.9 mm.; width at base, .4 mm.; at top, .3 mm.; somewhat curved, widest and rounded at the base, truncate at the top. The eggs forming the outer layer are of a burnt sienna color, those on the inside being of a pale amber. The upper end of the eggs is of a pale yellowish color, and bears immediately within the circumference a

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* For the identification of the species I am indebted to the kindness of Prof. P. R. Uhler.

† Mr. Robert A. Cooley, assistant entomologist, Massachusetts Hatch Experiment Station, informs me that he has found the eggs of this insect attached to the under surface of leaves of *Ostrya virginica* and *Betula lenta*.

narrow, circular, dark-brown band, while at the centre there is a small dark-brown dot. The areas covered by the circle and dot are depressed. Embryonic development was apparent June 22, and on June 29 the eggs hatched.

First Stage. — (Plate 2, Fig. 3.) The newly hatched bug, with legs and antennæ much longer than the body, presents indeed a most unique appearance. In this stage the nymph feeds readily on aphids, and does not hesitate to attack insects considerably larger than itself. Length of body, 2 mm.; of antennæ, 4 mm.; general color pale amber, darkening after the insect has taken food. Head large in proportion to the rest of the body, projecting between the antennæ. A transverse groove crosses the head behind the dark-red eyes. Beak reaching to the anterior coxæ. Basal joint of the filiform antennæ as long as the three outer joints. These latter are of nearly equal length. Thorax somewhat longer than either head or abdomen, with lateral projections on each segment. Legs long and very slender. Abdomen compact, sparsely hairy, with well-defined segmentation.

The young bugs were reared on aphids found on *Corydalis glauca* and *Hammamelis virginana*. On July 3 nearly all had passed the first molt.

Second Stage. — Length, 2.6 mm. General color darker than in preceding stage. Form similar, but abdomen much longer in proportion to the rest of the body than in first stage. Most unfortunately all the nymphs died soon after passing the first molt. In this stage the nymphs first showed the habit so common to the imago, of raising the fore legs above the head upon the slightest disturbance. The insects were apparently able to walk as well with but four legs as with six.

Full-grown Nymph; Fourth (?) Stage. — (Plate 2, Fig. 4.) Length, 11 mm. Body slender, elongated; color light green, faintly marked with brown. Head narrow, widest at the eyes, the latter being of a brick-red color. Behind the eyes the head is shaded with reddish brown. Thorax

short, with well-developed scutellum. Wing-pads extending about one-third the length of abdomen. Abdomen widened at the middle with lateral flanges developing with the approach of maturity. Near the posterior margins of the dorsum of each abdominal segment there is a faint reddish-brown spot, from which a light line extends forward on either side to the anterior margin, then bends at an acute angle and runs backward to the posterior angles of the segment. Antennæ filiform. Legs slender, anterior pair the stoutest; tarsi brown; claws dark brown.

Imago. — This species, along with a number of Mexican Hemiptera, was originally described by Stål in 1862 (Stettiner Entomologische Zeitung, 23 jahrgang, page 452) as *Zelus luridus*, from Carolinian examples. Uhler, in his check list of the Hemiptera Heteroptera of North America (1886), places the species in the genus *Diplodus*, as established by Amyot and Serville in their "Hemipteres" (1843), page 370. Lethierry and Severin, in their "Catalogue general des Hemipteres" (1896), have replaced the species in the genus *Zelus*. The sexual dimorphism existing in this species is worthy of note; unless otherwise informed, one might readily believe that the sexes of this insect represent different species.

Male. — (Plate 2, Fig. 5.) Length, 13 mm. Body nearly linear, dark brown, varying to black on the upper surface. Head narrow, elongated, and projecting to a blunt point between the bases of the filiform antennæ. First joint of the antennæ dilated at base, slender, and of about the same length as that of the head and thorax taken together; second joint one-third as long as first; third joint over two-thirds as long as first; fourth joint about the same length as second. Eyes prominent, dark reddish brown; ocelli large, in rear of the eyes on slight prominences of the head, which is widened at this place. Base of head smooth and shining. Prothorax dark brown, varying to black, rounded posteriorly and with a very small blunt black spine at the posterior angles. Two semi-lunar depressions extend inward from indentations in the sides of

the prothorax and meet at the dorsal line, whence a similar depression leads forward to the anterior margin. The areas thus included are slightly raised. Scutellum dark brown or black, tipped with pale yellow. Wings dark brown.

Under side of head and thorax and tip of abdomen pale sulphur yellow. Remainder of abdomen sordid yellow, darkest anteriorly. Beak yellow, brown at tip, reaching nearly to anterior coxæ. Legs slender; coxæ of same color as thorax; femora of same color at base, darkening outwardly. A narrow dark-brown band encircles the femora near their junction with the tibiæ. Tibiæ and tarsi dark brown.

Female. — (Plate 2, Fig. 6.) Length, 15 mm. Body much lighter and stouter than the male. Head pale brown in front of the eyes, but darker posteriorly. Thorax, scutellum and wings light yellowish brown. Posterior thoracic angles acute, tipped with a stout black spine. Under surface as in male. Antennæ pale brown, darker at joints. Legs pale brown; femora without bands; tarsi dark brown.

NOTES ON CERTAIN COLEOPTERA KNOWN TO ATTACK THE GYPSY MOTH.*

A. F. BURGESS, B.S.

Among the natural insect enemies of the gypsy moth in this country, next to certain Hemiptera, the predaceous Coleoptera should undoubtedly be given a place; and, although the latter species are not as beneficial as the Hymenopterous and Dipterous parasites in controlling some of our common injurious insects, their work with reference to the gypsy moth seems to warrant their occupying this prominent position. The most important of the beetles known to attack the gypsy moth are members of the family Carabidæ belonging to the genera *Calosoma* and *Harpalus*, and, on account of their voracity, size and rapid movements, have long been recognized as formidable enemies to Lepidopterous larvæ. They grasp their prey with the sharp mandibles, the favorite place being along some of the dorsal segments, and, after tearing away the integument, suck up the internal contents. As a rule they do not seem to show any particular preference as to their food, since almost all our injurious caterpillars, cut-worms, etc., are attacked by them to a greater or less extent, as is abundantly shown by reports on beneficial insects.

Another factor which makes the work of these beetles especially important is the predaceous habits of their larvæ, which have been known to feed on both the eggs and the young caterpillars of the gypsy moth. Previous to 1896 the following beetles had been found attacking the gypsy moth larvæ in the field: —

* The studies forming the basis of this paper were made at the experiment station and insectary of the gypsy moth committee during the summer of 1896. The description of the different stages and the drawings illustrating the same were completed at the entomological laboratory of the Massachusetts Agricultural College, under the direction of Prof. C. H. Fernald, entomologist to the committee.

Calosoma scrutator (Fab.), *Calosoma frigidum* Kirby, *Calosoma calidum* (Fab.), *Harpalus caliginosus* Say., *Harpalus pennsylvanicus* (DeG.), *Cicindela 6-guttata* Fab.* The larvæ of two species of *Harpalus* have been reported by Mr. C. H. Rowe as feeding on young gypsy moth caterpillars. *Platynus limbatus* (Say.) has been found feeding on the pupæ in the field, *Dermestes lardarius* Linn., reared from pupæ, and *Ptinus brunneus* Duft., reared from the egg-clusters. Several undetermined beetle larvæ have also been found feeding on the eggs.†

No new species have been found this year attacking the gypsy moth, but the life histories and habits of some of the more important of these beneficial insects have been investigated, with a view to obtaining a more accurate knowledge of the conditions favorable to their multiplication. The following pages contain the points of interest learned concerning these beetles, together with notes on the life histories of *Calosoma frigidum* and *C. calidum*.

Distribution. — The species of *Calosoma* and *Harpalus* above mentioned are as a rule quite generally distributed throughout the infested district, although they occur chiefly in sections to which, by reason of their peculiar habits, they are particularly adapted. Of these species, *Calosoma scrutator* is the least common, no doubt, for the reason that its large size, brilliant color and clumsy movements render it more susceptible to the attacks of its various enemies. Its occurrence is limited chiefly to wood and brush land. I am informed that the *Calosomas*, especially *scrutator* and *calidum*, are very abundant in brushland near the salt water at Belmont, N. J., so much so that it is very common for visitors to catch the brilliantly colored *scrutator* and wear it as an ornament. The occurrence of this species, in eastern Massachusetts at least, is more limited, and it is considered by many local collectors as a very rare beetle.

Calosoma frigidum is much more common, and is found in orchards where the grass has not been cut, in wood and

* Reported by Mr. Samuel Henshaw, Bulletin No. 26, U. S. Dept. Agri. Div. Ent., page 75

† "The Gypsy Moth," Forbush and Fernald, pages 384 and 385.

brush land; and I have taken specimens in the early summer (June 4) on the trunks of the large street elms in the city of Medford. Seven specimens of this insect were also taken by Mr. C. E. Bailey and myself in a small orchard in the same city. These latter were running about at the roots of the tall grass at some little distance from the trees. Judging from the experience this season, it would seem that, although this species is much more abundant than *scrutator*, its distribution is local rather than general, as is the case with *calidum*. The latter, popularly known as the fiery caterpillar hunter, is the most common species, and is very frequently found in thickly populated sections.

The two species of *Harpalus* are common in cultivated land, and are often found under stones or rubbish in pastures and to a more limited extent in woodland. The members of the group Carabidæ occur in localities where there is either natural or artificial protection. This is especially noticeable in wooded areas, where there is good forest cover and a moderate amount of moisture. A stone wall often furnishes them an excellent place of shelter, and it is not uncommon to find them when tearing down walls in the early spring.

One very significant fact has been noted this year, viz., that in localities where the beetles had been very common in previous years, no traces of any could be found even after careful search. This may perhaps be explained by the fact that the brush and rubbish which had served for their hiding places had been cleared up by the employees of the department, causing them to migrate to more suitable quarters.

Habits of the Beetles. — Many observations tend to show that the members of the genus *Calosoma* are nocturnal as well as diurnal in their habits. While sugaring for moths at Amherst in June, 1893, I took two specimens of *Calosoma calidum*. They were very active, and had climbed up one of the trees to the sugar band, a distance of five feet. Mr. A. H. Kirkland has also taken a specimen of this same species at Amherst, running about at 10 P.M., apparently in search of food. The stomachs of several toads which were

captured late in the evening, upon examination by Mr. Kirkland were found to contain specimens of *Calosoma calidum* intact, they having undoubtedly been swallowed only a short time previous. *Calosoma frigidum* observed in confinement has been found to feed at night as well as during the day. These facts show that the members of this genus under observation accomplish a great amount of good by their nightly raids against injurious insects.

Bearing in mind the fact that the gypsy moth caterpillars feed at night and seek shelter during the day, and that these beetles are active, climbing the trees at night, and are also busy searching out food in sheltered places during the day, we are led to believe that they are most valuable allies. The feeding habits of the different species vary somewhat, although all have been taken on the trunks of trees and under burlaps during the day. As a rule the number of gypsy moth larvæ killed on the trees depends upon the size and agility of the beetles. In point of efficiency they rank in the following order: *frigidum*, *calidum* and *scrutator; frigidum* is most skilful in this respect, and has been observed not only to feed on a vertical surface but to support itself and feed on the under side of a horizontal branch. A rise in temperature seems to stimulate their activity and the desire for food. Specimens of *Calosoma frigidum* observed in confinement during very hot weather were more active, ate more and laid a greater number of eggs than when the weather was cooler. When the temperature fell still lower they sought the ground, ate very little and seldom laid eggs. As far as observed, the members of this group depend entirely on their well-developed legs as a means of locomotion, although both sexes of *frigidum* have been observed to vibrate their hind wings in confinement, but when thrown in the air they do not make the slightest effort to fly.

Specimens of *C. frigidum* while confined in cages have been fed, in addition to the gypsy moth larvæ, pupæ and imagoes, the following caterpillars, which they ate freely: —

Euvanessa antiopa, *Grapta progne* (?), *Protoparce celeus*, *Hyphantria cunea*, *Euchætes egle*, *Halesidota caryæ*, *H. maculata*, *Orgyia definita* (pupa also), *O. leucostigma*

(pupa also), *Datana ministra*, *D. major*, *D. integerrima*, *Œdemasia concinna*, *Attacus promethea*, *A. cecropia*, *Clisiocampa americana*, *C. disstria*, *Acronycta* sp., *Rhynchagrotis alternata*, *Noctua c-nigrum*, *Leucania unipuncta*, *Pyrophila pyramidoides*, and *Catocala* sp.

Method of rearing Predaceous Coleoptera. — From the fact that the adult beetles not only spend part of their time in the ground, but that the eggs are laid in the soil and the young grubs are beneath the surface the greater part of their existence, accurate observations on the early stages are rendered quite difficult.

As a preliminary to the study of the early stages and habits of these insects, the limited literature upon the subject was carefully sought out and examined, although but little assistance was thus obtained; and active operations were commenced in the spring of 1896, as soon as living imagoes became available.

In order to compare results, the work was begun along two lines, both with a view to approaching as nearly as possible to natural conditions. One set of observations was made on beetles in breeding cages, out of doors, while the other set was made on a limited number of beetles confined in small glass jars, where they could be more closely watched.

For the first purpose, use was made of the cages devised by Mr. Kirkland in 1895, for studying the feeding habits of the imagoes. These were attached to trees near the insectary. They were made of wire netting, bent into a nearly cylindrical form. The edges were fastened to the two sides of the tree trunk, the lower end extending down into the ground and the upper end covered by a piece of cloth, one side of which was secured to the tree, the other covering the top of the wire screen cage and held in place by a rubber strap, the ends of which were fastened to the trunk of the tree.*

In one of these cages two males of *C. frigidum* were placed June 6, but at the end of ten days both had died. The beetles of the same species which were placed in the

* "The Gypsy Moth," Forbush and Fernald, page 384.

other cages escaped in some unknown way, and, as the chance of finding the eggs in such cages was very small, further attempts along this line were abandoned.

For the other line of investigation, common jelly tumblers, containing about two inches of earth, were used, the tops of the jars being covered with pieces of muslin which were held in place by rubber bands. A pair of beetles were placed in each jar, with gypsy moth larvæ for food and with fresh leaves to serve as food for the larvæ. At first the jars were kept in the insectary, but when the weather became excessively hot it was thought best to place them out of doors, and a large box with a screen cover was selected for the purpose. The jars were examined daily, and when eggs were found in the earth the beetles were changed to other jars, those formerly occupied not being disturbed until the eggs hatched, when the earth was examined and the number of young larvæ carefully noted. Great care had to be exercised in not allowing the grubs to remain together too long, as under these conditions they soon develop cannibal tendencies, and readily devour each other.

During the extremely warm weather, about the middle of July, many of the grubs which had heretofore seemed healthy began rapidly to sicken and die. Thinking that perhaps more natural conditions could be obtained, I made a cage consisting of a box twenty-four inches long and five inches square, the lower end being covered with a wire screen. The box was sunk in the ground and nearly covered with soil, the top being covered with muslin held in place by an elastic band. Although great care was taken to feed and watch the grubs, at the end of eight days all had died. Later more young grubs were placed in the cages, but the results were very unsatisfactory. On account of these discouraging results, careful attention was given to the insects confined in the jars. Later in the season a number of eggs of *C. frigidum* and *C. calidum* were thus obtained, and, upon hatching, the young larvæ were isolated. A part of these larvæ remained healthy, and with great care I was able to rear a few through their successive stages.

Life History of Calosoma frigidum Kirby.

Oviposition. — The eggs are laid at intervals of a few days from early June until about the first of September, the length of this period depending somewhat on the weather. Soon after pairing, which takes from one to two and one-half minutes, the female beetle seeks the ground. The eggs are deposited from one-eighth to two inches below the surface, and are often laid at night. They are dropped separately, without any regularity of arrangement. The greatest number of eggs deposited by a single female in twenty-four hours was seventeen.

The following table shows the record of the pairing and egg-laying of nine female imagoes of *C. frigidum.* The jars in which the beetles were confined were examined daily, but the days when no eggs were found have been omitted from the table. The figures indicate the number of eggs found; the sign "×" indicates that the beetles were observed to copulate; the "?" indicates that a greater number of eggs than are here recorded were doubtless originally deposited in the jar, but that upon hatching a part of the young grubs were probably consumed by the older larvæ. The figures in these cases give the number of larvæ actually found in the jars at the time of examination.

DATE.	No. 2.	No. 3.	No. 5.	No. 6.*	No. 7.†	No. 8.‡	No. 9.	No. 10.§	No. 11.‖
June 4, . .	×	×	-	-	-	-	-	-	-
5, . .	17	1	-	-	-	-	-	-	-
6, . .	-	1	6	14	-	-	-	-	-
7, . .	-	-	4	2	-	-	-	-	-
8, . .	-	×1	-	-	-	-	-	-	-
9, . .	-	-	-	8	-	-	-	-	-
10, . .	-	-	×	-	-	-	-	-	-
11, . .	-	1	-	-	-	-	-	-	-
12, . .	-	-	-	12	-	-	-	-	-

* Laid well while the weather was hot and food plenty.

† No eggs laid after male died.

‡ Although seven weeks together no eggs were laid.

§ No eggs laid until male was received.

‖ Male feeble when put in.

DATE.	No. 2.	No. 3.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.	No. 11.
June 17, . .	-	-	×	-	Put in June 19.	Put in June 19.	-	-	-
21, . .	-	-	×	-	-	-	-	-	-
26, . .	-	-	1	-	-	-	Put in June 26.	Put in June 27.	Put in June 27.
July 11, . .	-	Female died.	-	-	-	-	-	Male receiv'd from No. 3.	-
13, . .	-	-	Male died.	14	-	-	-	2	-
14, . .	-	-	-	5	×	-	-	9	-
15, . .	-	-	-	-	-	-	-	7	-
16, . .	-	-	-	4	2	-	-	-	-
17, . .	-	-	-	2	-	-	-	-	-
18, . .	-	-	-	-	1	-	-	-	-
20, . .	-	-	-	5	-	-	-	-	-
21, . .	-	-	-	2×	-	-	-	-	-
22, . .	-	-	-	6	Male died.	-	-	-	-
23, . .	-	-	-	×	-	-	-	-	-
24, . .	-	-	-	10×	-	-	-	-	-
26, . .	-	-	-	12	-	-	-	-	-
27, . .	-	-	-	6×	-	-	-	4	-
28, . .	-	-	-	6	-	-	-	-	-
29, . .	-	-	Female died.	-	-	-	-	-	-
31, . .	-	-	-	11	-	-	-	-	-
Aug. 1, . .	-	-	-	13	-	-	-	-	-
4, . .	-	-	-	2?	-	-	-	-	-
5, . .	-	-	-	4?	-	-	-	-	-
6, . .	-	-	-	10?×	-	-	-	-	-
7, . .	-	-	-	10	-	Female died.	Male receiv'd from No. 8.	-	Male put in.
8, . .	-	-	-	7?	-	-	-	-	-
10, . .	-	-	-	9	-	-	-	-	Male died.
11, . .	-	-	-	2	-	-	-	-	-
13, . .	-	-	-	8	-	-	-	-	-
15, . .	-	-	-	-	-	-	-	1	-
19, . .	-	-	-	2	-	-	-	-	-
	17	4	11	186	3	-	-	23	-

As will be seen by the table, the beetles show a great difference as regards the number of eggs laid; but the fact is also noticeable that no eggs were deposited by any female which had not paired. There were very few cases where the eggs failed to hatch, and these I think were due to the injuries the eggs may have received while removing the beetles from the jars. Probably the number laid by female No. 6 is the nearest typical, though doubtless under favorable natural conditions the number would be materially increased.

The Egg. — (Plate 3, Fig. 1.) The eggs are somewhat elliptical in form, but slightly larger at one end. Although subject to variation, they measure 4 mm. in length and 1.9 mm. in diameter, and are of a light straw-yellow color. With a lens or low power of the microscope the surface of the egg looks perfectly smooth, but if the contents are removed and the shell placed under a high power it is found to be very finely reticulated. These markings (Fig. 2) are pentangular in form, and may be readily observed on shells mounted in glycerine jelly. Sometimes the eggs change their form and become slightly kidney-shaped before hatching. The color, however, does not change. The time spent in this stage is from four to ten days.

First Larval Stage. — (Plate 3, Fig. 3.) At the time of hatching the young larva is of the same color as the egg, but gradually grows darker, until in about ten hours it is of a deep shining brown. After remaining in the cavity occupied by the egg for about twenty-four hours, the larva comes to the surface of the ground in search of food. At this time the length is 8 mm., including the caudal appendages, which measure 1 mm.; the width at the middle of the first thoracic segment is 1.7 mm., from which point the body tapers gradually to the last segment. The head is large in proportion to the body, longer than wide, somewhat flattened, and truncate behind. The clypeus is separated from the epicranium by a well-defined suture, which extends to the base of the antennæ, dividing the raised portions from which they arise. The front edge of the clypeus is emarginate,

and bears a prominent hair at each anterior angle. There are also three pairs of hairs situated on the forward part of the clypeus and two pairs directly between the eyes, one pair being on the clypeus and one on the epicranium. Antennæ setaceous, four jointed and ferruginous. Eyes conspicuous, and situated in groups of six each, on slight elevations just behind the antennæ. The mandibles are dark brown in color, long, simple, stout at base, but quite pointed at the tip, the left mandible often folded over the right. The maxillæ and labium are small, ferruginous and provided with well-developed palpi. Prothorax large, as long as the meso- and meta-thorax, slightly contracted and rounded posteriorly. Meso-thorax slightly rounded posteriorly; meta-thorax truncate. Lateral edges of the body segments slightly produced. Dorsal line prominent on all the segments except the last. On the dorsum of each thoracic segment there are ten short hairs, one on the anterior part of each lateral margin, one at each angle of the segment and one on each side of the dorsal line at the anterior and posterior margins. Abdominal segments, nine in number, with the exception of the last, truncate behind, the last segment being rounded posteriorly and bearing a pair of caudal appendages. Each segment except the last bears six hairs, one on each lateral margin and two on each side of the dorsal line at the posterior margin. The last abdominal segment bears a pair of hairs on each lateral margin, but none on the dorsum. The caudal appendages are entire, although probably jointed at the base, and bear numerous hairs. The spiracles are situated just below the dorsal plates. The ventral portion of the body is of a yellowish white except the portions which are strengthened by chitinous plates. These are of the same color as the dorsal part of the body. Legs well developed, provided with stout spines which are especially prominent at the joints, the tarsi bearing two claws. The last body segment bears on the posterior ventral portion an appendage which serves as a proleg and aids in locomotion. The larva remains in this stage about four days. Molting is accomplished by a splitting of the thoracic plates along the dorsal line; the head, mouth parts and legs are then withdrawn and the exuviæ forced back

over the posterior end of the body. The newly molted larva is of a pale straw color.

Second Stage. — (Plate 3, Fig. 4.) Length, 15 mm.; width, 3 mm. Form somewhat stouter than in the preceding stage. Head relatively smaller, flattened, as wide as long; eyes less prominent. Clypeus deeply emarginate in front and feebly incised at the middle. Antennæ and mouth parts relatively the same as in the last stage; the body, however, is of a somewhat paler brown color. All the body segments except the last are truncate behind, and bear a well-defined dorsal line. The first thoracic segment is broadest posteriorly and gradually narrows toward the head, but is not quite as wide as the two succeeding segments. The hairs are arranged the same as in the first stage, except that two pairs of hairs arise on the lateral edges of each segment up to the last, which bears only one pair. The caudal appendages are entire but not quite as prominent as in the previous stage, and the legs are a little more slender. The time spent in this stage varies from four to eleven days.

Third Stage. — (Plate 3, Fig. 5.) After molting the larva measures 22 mm. in length and 4 mm. in width, and is of a light mahogany-brown color, which soon changes to a dark seal brown. The mandibles are stout, and bear a prominent carina. The clypeus is deeply bilobed in front, the hinder border separated from the epicranium by a somewhat indistinct suture. Prothorax narrowed in front and much wider behind. Caudal appendages each provided with a blunt spine, which is thickened at the base and arises from the dorsal surface. When full grown (Plate 4, Fig. 1) the larva is very stout, and measures 32 mm. in length and 6 mm. in width. A detailed description of the full-grown larva follows: —

The head is of medium size, slightly flattened and of the same color as the body. Clypeus somewhat shield shaped. A faint line separates the clypeus from the epicranium and reaches to the base of the mandibles, but does not divide the raised portions which bear the antennæ. Front edge

of clypeus strongly bilobed, each anterior angle bearing a prominent spine; top of the clypeus slightly hollowed toward the dorsal line. The spines are the same in number and arrangement as in the previous stages. Eyes near base of antennæ, not prominent. The antennæ (Plate 3, Fig. 6) are setaceous, short, four jointed, and arise from an elevation at the base of the mandibles. First joint short, cylindrical and naked; second joint nearly twice as long, slightly clavate and bearing a short hair near the middle of the outer margin; third joint a little shorter than the second, somewhat clavate and having one anterior angle slightly produced, and bearing three spines, which arise near the outer angles; last joint as long as the first, nearly cylindrical and bearing three spines at the apex. Mandibles large, stout at base, with a prominent dorsal carina. A strong, simple, blunt tooth (Fig. 9) arises near the base. The mandible gradually tapers from the outermost insertion of this tooth to a somewhat chisel-shaped point. The maxillæ (Fig. 8) are small, ferruginous in color, and are densely covered with hairs and spines. They bear four-jointed, naked palpi, which are nearly as long as the antennæ. The three inner segments of the maxillary palpus are short, stout, truncate and of nearly equal length; the terminal joint is slightly longer than the two preceding joints, oblong ovate in form and truncate at the tip. The galea or inner lobe is naked, two jointed and as long as the three basal joints of the palpus. Lacinia prominent and bearing a spine at its apex. Labium (Fig. 7) small, somewhat halbert shaped, with numerous spines arranged in an oval row on the inner side. Palpi two jointed; outer joint the longer and truncate at tip.

The dorsal thoracic plates are large, and nearly cover the lateral thoracic walls, while the dorsal abdominal plates, with the exception of the last, are smaller, and allow the lateral walls of the abdomen to protrude. Dorsal line not prominent. Each abdominal plate except the last bears, near the posterior margin, a very feeble transverse carina. Spines are arranged as in the preceding stage. The last segment (Plate 4, Fig. 4) is relatively small, nearly truncate behind; the caudal appendages of moderate length, and

each bears on the upper surface a large, blunt, horn-like protuberance, which is terminated with a bristle. Numerous other hairs occur on these caudal appendages. The ventral portion of the body is yellowish white except the parts which are strengthened by chitinous plates.

Spiracles seal brown, nine on each side, borne in shallow depressions just below the lateral edges of the dorsal plate, on the meso-thorax and on each abdominal segment except the last. Those on the abdominal segments are small and circular, while the thoracic spiracles are decidedly larger and elliptical in outline. Legs (Fig. 7) small, very muscular and spiny. Coxæ very stout, dark brown; trochanters, femora and tibiæ slender, reddish brown; tarsi of same color, one jointed and bearing two simple claws. The anal proleg is slender, tapering and bears a number of short spines. This appendage serves the double function of acting as an organ of locomotion and also containing the cavity into which the rectum discharges. General color of under surface sordid white, varying to light gray, variously marked with light seal-brown patches. Head and anterior part of prothorax seal brown. Two lateral rows of elongated markings of similar color extend along the body beneath the spiracles. The upper row terminates on the penultimate segment, the lower row on the last segment.

The markings forming the upper row are single and entire on the first two thoracic segments; on the metathorax there are two spots, the anterior being the smaller. On the abdominal segments the markings are somewhat circular, two to each segment, a large orbicular marking being followed posteriorly by a smaller one of similar shape. The markings composing the lower row are in general elliptical, and occur singly on the segments stated. On both the meso- and meta-thorax there is a single small brown spot on the median line. In a corresponding position on each of the following segments except the last two, and near the anterior margin, there is a large elliptical, transverse, seal-brown spot. Posterior to this marking on each of the segments mentioned there is a transverse row of four small spots of similar color. On the last two segments the median spot is quite large and somewhat pentagonal in out-

line. The transverse row of small spots occurring on the preceding segments is here absent.

After the last molt the larva feeds for about three weeks, during which time it grows very rapidly. It then ceases feeding, burrows a little distance below the surface of the ground and makes a small chamber. The body shortens somewhat, and in less than a week pupation takes place, and is accomplished in the same way as the molting in the previous stages. In several instances the larvæ have molted three times before pupating.

Pupa. — (Plate 5, Figs. 1, 3.) Eighteen mm. long, 6.4 mm. wide at the first abdominal segment. Oblong, somewhat elliptical and flattened. General color of the body pale amber. Head medium, somewhat flattened in front and strongly depressed beneath the thoracic segments. Eyes prominent, seal brown in color. Antennæ and mouth parts free, translucent. Prothorax broader than long, considerably narrowed behind; meso-thorax emarginate in front and two-thirds as long as the meta-thorax; all separated by well-defined sutures. Wing-covers translucent and extending beyond the third abdominal segment. Abdominal segments nine in number, the sides of the body protruding beyond the dorsal portions. The lateral edges of abdominal segments two to six are produced to a blunt point, within which is a slight depression. Penultimate segment slightly depressed; last segment greatly depressed beneath the body, and bearing on the posterior margin a pair of small anal stylets. Each of the first five abdominal segments bears a narrow brush of erect brown hairs, which extends two-thirds of the distance across the segment (not shown in Fig. 1). The nine pairs of spiracles are light chestnut brown, and are situated in the same relative position as those of the larva; they are larger, however, and elliptical in outline, those on the meta-thorax being the largest. Legs free, translucent and nearly surrounded by the wing-covers.

Unfortunately all the larvæ reared to pupæ died before emerging, hence I am unable to give the length of the period spent in this stage.

*Imago.** — Length, 18 to 22 mm. General color metallic black above and greenish black below. Thorax and elytra bordered with a more or less greenish band. Head medium in size, profusely punctured. Mandibles (Fig. 5) large and prominent. Third joint of antennæ (Fig. 4) slightly compressed. Prothorax small, narrowed posteriorly, the lateral edges slightly produced.

The posterior two-thirds of segment bears a quite prominent impressed dorsal line. Thorax with granular punctures. Elytra striate, each bearing three rows of small impressed greenish dots. Under side of the body somewhat wrinkled and punctured. Fore tarsi of the female (Fig. 6) simple. Fore tarsi of male (Figs. 7, 8) have the first four joints hairy beneath; this character is not only of value as a means of determining the sexes, but is also of specific importance.

Calosoma calidum (Fab.).

A male and female *Calosoma calidum*, which were taken early in September, 1896, were immediately placed in a breeding jar. On September 3 they were observed to copulate, and on the following day fourteen eggs were found in the jar. Three of these eggs were preserved for study, but, owing to the death of a number of the larvæ during the early stages, only four pupated. From these survivors the following brief notes on the life history of this species were prepared: —

Egg. — (Plate 4, Fig. 2.) Length, 4 mm.; width, 1.7 mm. Form similar to that of *C. frigidum*, but tapering somewhat more toward the lower end. Color, light amber. Hatching took place in seven days from the date of oviposition.

First Stage. — Length, 8 mm.; width, 2 mm. at third thoracic segment. Form ellipsoidal, tapering more gradually toward the last segment than in the corresponding stage of *C. frigidum*. General color of the body and

* For figure of imago see "The Gypsy Moth," Forbush and Fernald, Plate 53, Fig. 1, 1896.

mouth parts dull black, not shining. Head large, as long as wide, dorsal surface flattened; palpi prominent, longer than antennæ. Posterior margin of the head somewhat emarginate at the centre. First thoracic segment as long as the two following, slightly wider than the head and edges produced laterally. All the body segments except the last are truncate behind, and bear a prominent impressed dorsal line. Caudal appendages present, simple and provided with numerous spines.

Ventral portion of the body nearly pure white, but is profusely covered with small black chitinous plates. Spiracles nine, black, circular and arranged just below the lateral edges of the dorsal plates. Anal proleg moderately stout. After feeding for a week the larvæ molted.

Second Stage. — Soon after molting the larvæ became black and measured 18 mm. in length. Body somewhat stouter than in preceding stage. Head longer than wide, emarginate behind. Prothorax wider than the head. Dorsal line quite prominent. Abdominal segments truncate and slightly produced laterally. The second molt occurred at the end of a week.

Third Stage. — The following description was not made until the larva was almost ready to pupate. Length, 30 mm. Color, dull black. Head of medium size, flattened, truncate behind. Clypeus slightly broader in front than in *C. frigidum*. Strongly bilobed. Suture between clypeus and epicranium sub-obsolete. Mandibles stout, the large tooth (Plate 3, Fig. 10) near the base being deeply cleft on the inner margin. Prothorax longer than the head, the hind angles slightly curved. Meso- and meta-thorax smaller, but similar in shape, each thoracic segment bearing four pairs of hairs on the dorsal plate. The abdominal plates one to seven of the same form and bearing a moderate carina near the posterior edge of the segment. Eighth segment a little larger, slightly wider, and also bearing a carina, lateral edges of each abdominal segment bearing three short hairs. The last segment (Plate 4, Figs. 5, 6) small, posterior angles produced backward, but hind edge

of segment truncate; caudal appendages long, blunt, spiny, slightly depressed, and bearing on the upper surface a hump-like protuberance provided with a few spines. The spiracles are nine in number, and are arranged the same as in *C. frigidum;* the color, however, is black. Legs small and spiny, tarsi bearing two claws. The anal proleg is stout and covered with numerous short hairs. The under surface is of a purer white than in *C. frigidum*, but bears similar markings. The latter resemble those of the preceding species in form and arrangement, but are slightly darker in color. The spots composing the first lateral row are more elongated, and all the ventral spots are somewhat larger than in the preceding species. The time spent in this stage is about one month, of which about three weeks are passed in feeding. When full grown the larva burrows into the ground to a depth of several inches, and after preparing a cavity throws off its skin and goes into the pupa stage.

Pupa. — (Plate 5, Fig. 2.) The pupa resembles that of *C. frigidum* very closely, but is stouter and less compressed at the anterior and posterior ends. Other differences occur in the shape of the prothorax, which is not nearly as rounded in front as in *C. frigidum.* The anterior margin of the meso-thorax is transverse; the lateral projections of the dorsal abdominal segments are not as marked as in *C. frigidum.* Anal stylets larger, more prominent. Brushes of hairs present on the first five abdominal segments. The figure shows a part pushed out from beneath the last abdominal segment. All the pupæ died before spring.

Habits of the Larvæ. — The larvæ of this genus of beetles are called indiscriminately by the common names of "cut-worm lion," "corn grub killer," etc., although these names have been referred more particularly to the larva of *C. calidum.* The reason for such names is very apparent, since the larvæ are often found in gardens, and do a great amount of good in killing cut-worms and other injurious caterpillars. They have also been reported as feeding on the Colorado potato beetle larva (*Doryphora decemlineata*),

canker worms (*Paleacrita vernata*), May beetle (*Lachnosterna fusca*), eggs of the Rocky Mountain locust and numerous cut-worms.

Mr. F. H. Mosher informs me that he has found these larvæ quite numerous during the past summer under burlaps on an estate in Brookline which was quite badly infested by the gypsy moth. Without doubt these insects would do a great amount of good by killing the gypsy moth larvæ which would seek shelter below the burlap. If this habit of hiding in concealed places on trees, as under loose bark, etc., is constant among these beetle larvæ, a great many of the caterpillars as well as eggs of the gypsy moth must be destroyed every season. In confinement I have found that larvæ of *C. frigidum* will feed quite freely on the gypsy moth egg-clusters.

The amount of food consumed by a larva of *C. frigidum* in confinement was as follows: during the first stage one small cut-worm, three second-molt gypsy moth larvæ and one third-molt gypsy moth larva; second stage, two fall web worms (*Hyphantria cunea*), one larva of *Datana ministra*, one army worm (*Leucania unipuncta*) and one-half of a gypsy moth egg-cluster; third stage, two *Datana integerrima*, two *D. ministra*, one *Attacus promethea* and six army worms.

Under natural conditions this amount would be probably somewhat increased. The larvæ also ate gypsy moth pupæ quite readily, especially directly after pupation, before the bodies had become hard, the most favorable place for attack on the hardened pupæ being a point at the base of the wing-covers.

The larvæ are very ferocious, and do not hesitate to attack a caterpillar on account of its size or strength. They commonly grasp the victim by some of the ventral segments, and cling with great tenacity until the caterpillar succumbs. If perchance the little larva is shaken off, he persistently renews his attack with greater zeal than before. After succeeding in cutting a hole through the integument with his sharp mandibles, he sucks in the viscera of his prey and often becomes gorged almost to the point of bursting. He next repairs as rapidly as his condition will allow to a place of shelter, for which loose leaves, rubbish or

something of this description serves his purpose. Here he remains dormant for a short time, when he is ready to start out again in search of more prey.

Wintering or Hibernation of Carabidæ. — During the winter and early spring occasional trips were made to different parts of the infested district in order to learn, if possible, how this group of insects spends the winter. Species from the following genera were collected: *Pterostichus*, *Amara*, *Platynus*, *Lebia*, *Dromius*, *Pinacodera*, *Brachynus*, *Harpalus*, *Anisodactylus*. Mr. W. S. Blackley reports in Psyche 217 species of Carabidæ collected in the winter in Virgo County, Indiana.

There can be little doubt of the fact that many of this family spend the winter in the adult stage.

On March 22, 1896, I received from Mr. W. C. Colt a specimen of *Cychrus lecontei* (Dej.), which he found on the trunk of a tree in Medford on the previous day. Doubtless this insect hibernated as an adult.

In addition to the foregoing, the fact that *Calosoma calidum* was taken less than a month later leads to the conclusion that the Calosomas as a rule hibernate as adults, although it is possible that they may pass the winter in some other stage.

Natural Enemies. — Many natural influences conspire to limit the numbers of these beneficial insects. From their large size and conspicuous colors they cannot be otherwise than an attractive article of diet for some of our larger insectivorous birds. The pungent odor given off by these beetles would seem to be in a measure a means of defence; yet it is a well-known fact that some birds, like the crow, appear to prefer such malodorous insects.* In this connection it may be of interest to record that the fluid producing the characteristic odor of *C. calidum* is ejected by the beetle as a fine spray.

On one occasion, while examining the earth in a jar containing a female *Calosoma calidum*, on touching the back of the beetle with a brush a fine spray struck my face, which was about eight inches distant from the beetle. It

* See "The Common Crow," Bulletin Division of Ornithology and Mammalogy, Barrows-Schwarz, page 59, 1895.

had a very pungent odor, and produced a stinging sensation on the skin. Some that struck in the corner of my eye was very painful until the eye was washed with water. The fluid is probably expelled from anal glands, as in the case of the allied genus, *Brachynus*. Undoubtedly the insectivorous birds are the chief agency in checking the increase of these insects, although the terrestrial habits of the beetles render them an easy prey to the ever-watchful toad, while in woodlands many are probably destroyed by skunks. I have been unable to observe any of our common birds feeding upon these beetles, yet it seems probable that they may be devoured by the majority of those insectivorous species known to seek a part of their food upon the ground. In this class Gentry * gives the following as feeding upon the Carabidæ: the crow, blue jay, king bird, black-billed cuckoo, yellow-billed cuckoo, hairy woodpecker, downy woodpecker. Forbes records the robin,† cat bird and several thrushes as attacking Carabidæ, while Beal ‡ states that thirteen per cent of the food of the purple grackle consists of carabids. The same author § notes the occurrence of *Calosoma calidum* in the stomach of a red-headed woodpecker, while Schwarz ‖ found that this species is commonly devoured by the crow.

One would hardly expect that so ferocious and strongly chitinized an insect as *C. calidum* would suffer from the attacks of parasites, yet that such is sometimes the case is evident from the fact that on June 6, 1896, I took a specimen of this species which bore on the side of the prothorax a cluster of nine Dipterous eggs. After keeping the beetle a few days in confinement he became sluggish and finally died June 12. On the 28th seven flies had emerged, and on opening the beetle the empty puparia were found within. The flies were sent to Prof. L. O. Howard, Washington, D. C., and were referred to Mr. D. W. Coquillett, who kindly identified them as *Pseudotrætocera calosomæ* Coq., a species that he has bred in California from *Calosoma peregrinator*.

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* "Birds of Eastern Pennsylvania," 1877.

† Bulletin 3, Illinois State Laboratory of Natural History, 1880.

‡ Year Book, United States Department of Agriculture, 1894, page 240.

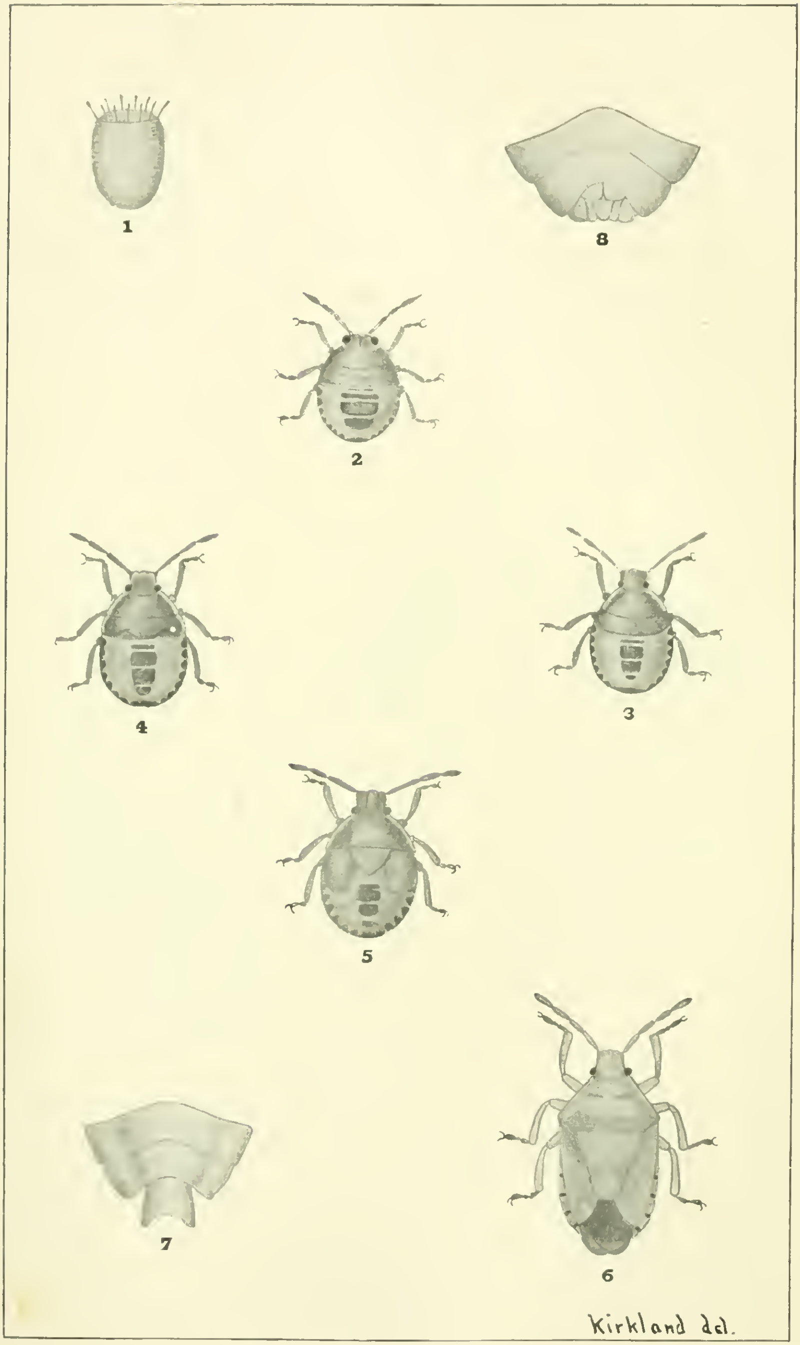
§ Bulletin No. 7, United States Department of Agriculture, Division of Ornithology and Mammalogy, page 24, 1895.

‖ "The Common Crow," page 59.

EXPLANATION OF PLATES.

PLATE 1:	Fig. 1, egg of *Podisus placidus* Uhl.,	. . . .	× 13
	2, first stage of *P. placidus*,	. . . .	× 9
	3, second stage of *P. placidus*,	. . . .	× 6
	4, third stage of *P. placidus*,	. . . .	× 4
	5, fourth stage of *P. placidus*,	. . . .	× 3
	6, imago of *P. placidus*,	. . . . .	× 3
	7, male genitalia of *P. placidus*, greatly enlarged.		
	8, female genitalia of *P. placidus*, greatly enlarged.		
PLATE 2:	Fig. 1, egg-mass of *Diplodus luridus* (Stål), enlarged.		
	2, single egg of *D. luridus*, greatly enlarged.		
	3, first stage of *D. luridus*, greatly enlarged.		
	4, full-grown nymph of *D luridus*,	. . .	× 2
	5, male imago of *D. luridus*,	. . . .	× 2
	6, female imago of *D. luridus*,	. . . .	× 2
	7, full-grown nymph of *Dendrocoris humeralis* (Uhl.),	. . . .	× $3\frac{1}{2}$
	8, imago of *D. humeralis*,	. . . . .	× $2\frac{1}{2}$
	9, head of imago of *D. humeralis*, greatly enlarged.		
	10, antenna of *D. humeralis*, greatly enlarged.		
	11, egg of *Euschistus politus* Uhl., greatly enlarged.		
	12, imago of *E. politus*,	. . . . . .	× $2\frac{2}{3}$
	13, antenna of *E. politus*, greatly enlarged.		
	14, wing-cases of *E. politus*, greatly enlarged.		
PLATE 3:	Fig. 1, egg of *Calosoma frigidum*,	. . . . .	× $4\frac{1}{2}$
	2, reticulations on egg shell,	. . . .	× 300
	3, first laval stage of *C. frigidum*,	. . .	× 6
	4, second larval stage of *C. frigidum*,	. .	× 4
	5, third larval stage of *C. frigidum*,	. . .	× $3\frac{1}{5}$
	6, antenna of larva of *C. frigidum*,	. . .	× 20
	7, labium of larva of *C. frigidum*,	. . .	× 20
	8, maxilla of larva of *C. frigidum*,	. . .	× 20
	9, mandible of larva of *C. frigidum*,	. . .	× 20
	10, mandible of larva of *C. calidum*,	. . .	× 20
PLATE 4:	Fig. 1, full-grown larva of *C. frigidum*,	. . .	× $2\frac{1}{2}$
	2, egg of *C. calidum*,	. . . .	× $4\frac{1}{2}$
	3, full-grown larva of *C. calidum*,	. . .	× $2\frac{1}{2}$

PLATE 4':	Fig.	4, last abdominal segment of larva of *C. frigidum*,	×	5
		5, last abdominal segment of larva of *C. calidum*,	×	5
		6, last abdominal segment of larva of *C. calidum*, showing cavity in anal proleg, . . .	×	5
		7, larval leg of *C. frigidum*, ...	×	12
		8, labium of *C. frigidum* (imago), . . .	×	10
		9, maxilla of *C. frigidum* (imago), . . .	×	10
PLATE 5:	Fig.	1, pupa of *C. frigidum* (dorsal view), . .	×	3½
		2, pupa of *C. calidum* (dorsal view), . . .	×	3½
		3, pupa of *C. frigidum* (lateral view), . .	×	3½
		4, antenna of *C. frigidum* (imago), . . .	×	5
		5, mandible of *C. frigidum* (imago), . . .	×	10
		6, fore leg of female *C. frigidum*, . . .	×	4
		7, fore leg of male *C. frigidum*, ...	×	4
		8, fore tarsus of male *C. frigidum* (under surface), ...	×	4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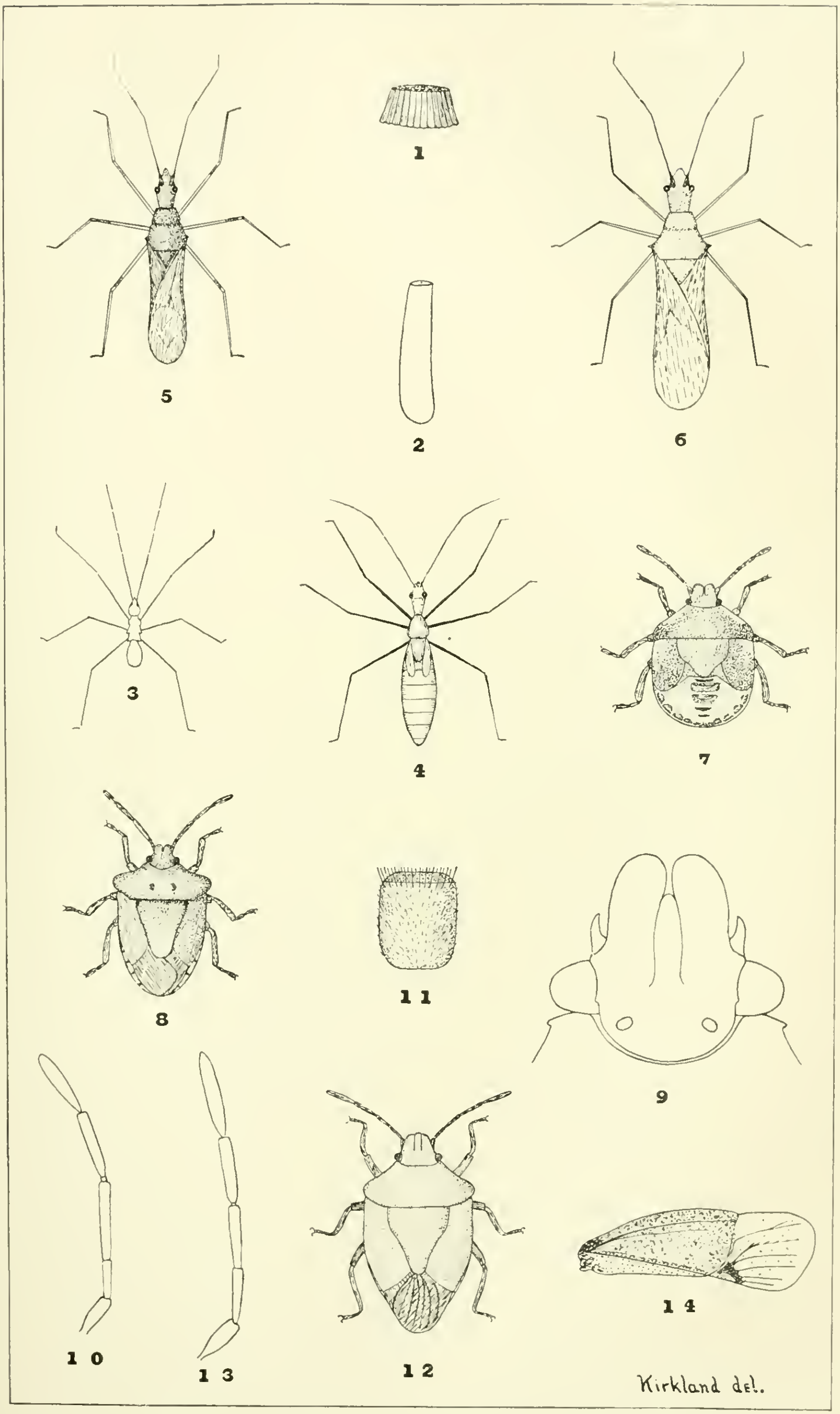
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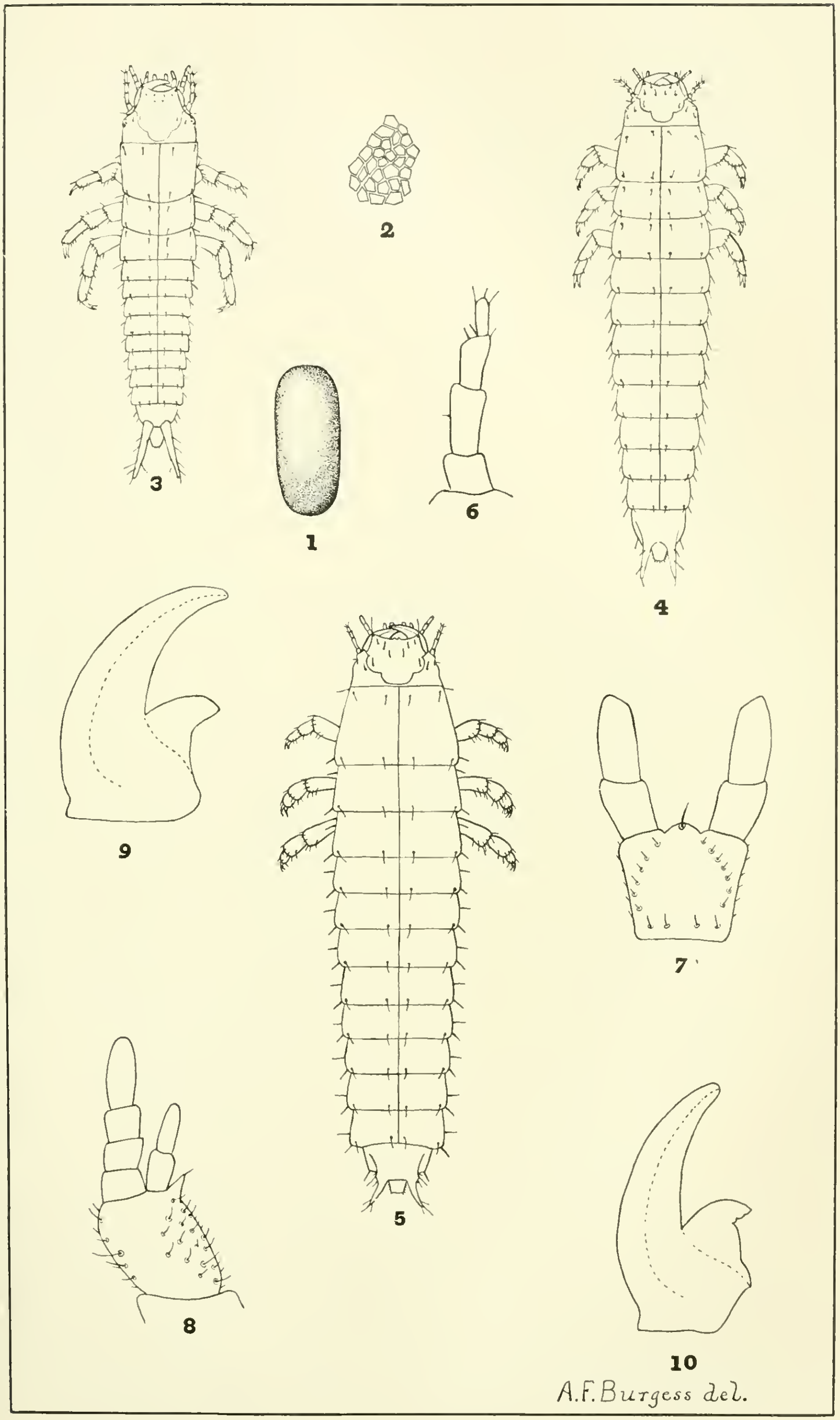
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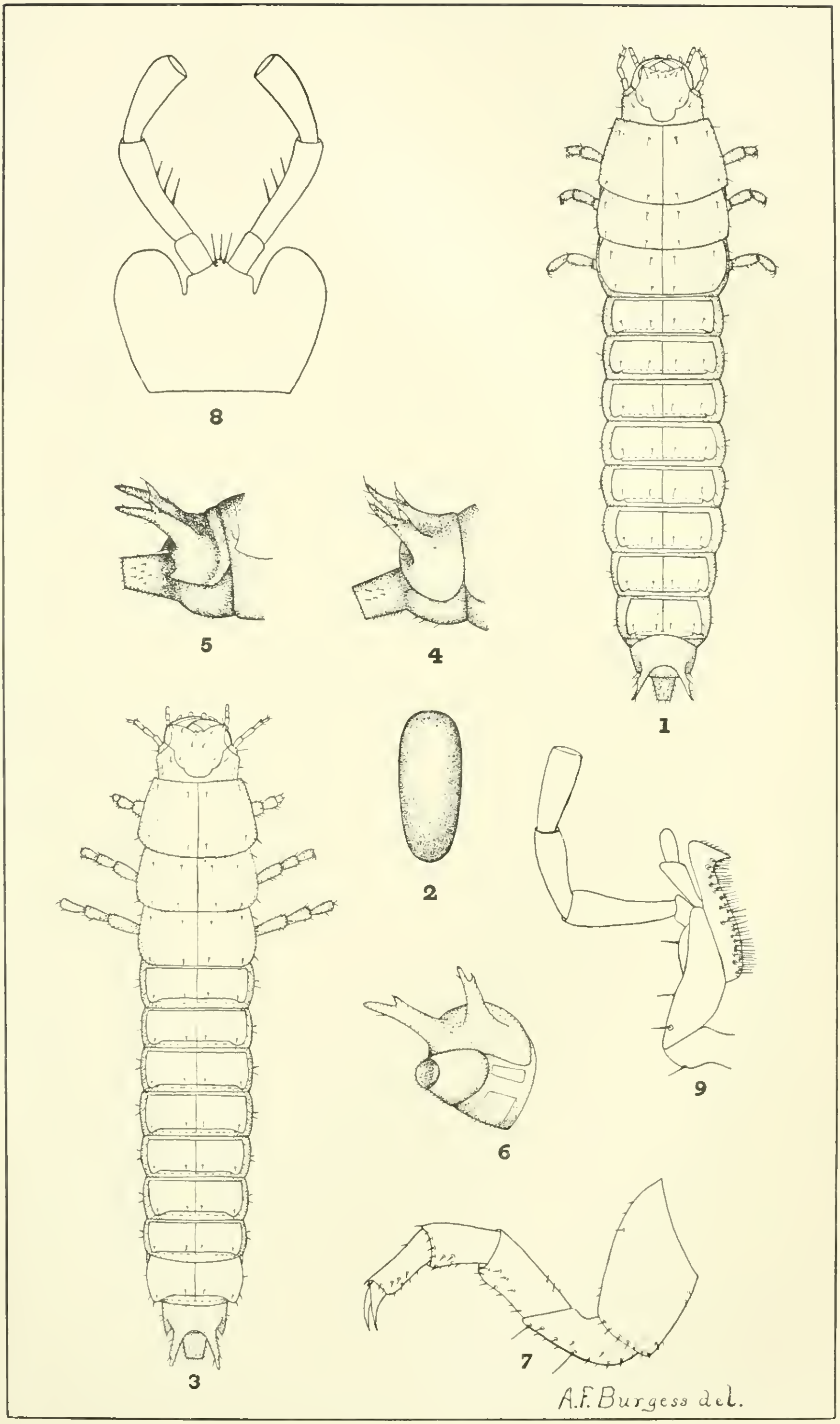
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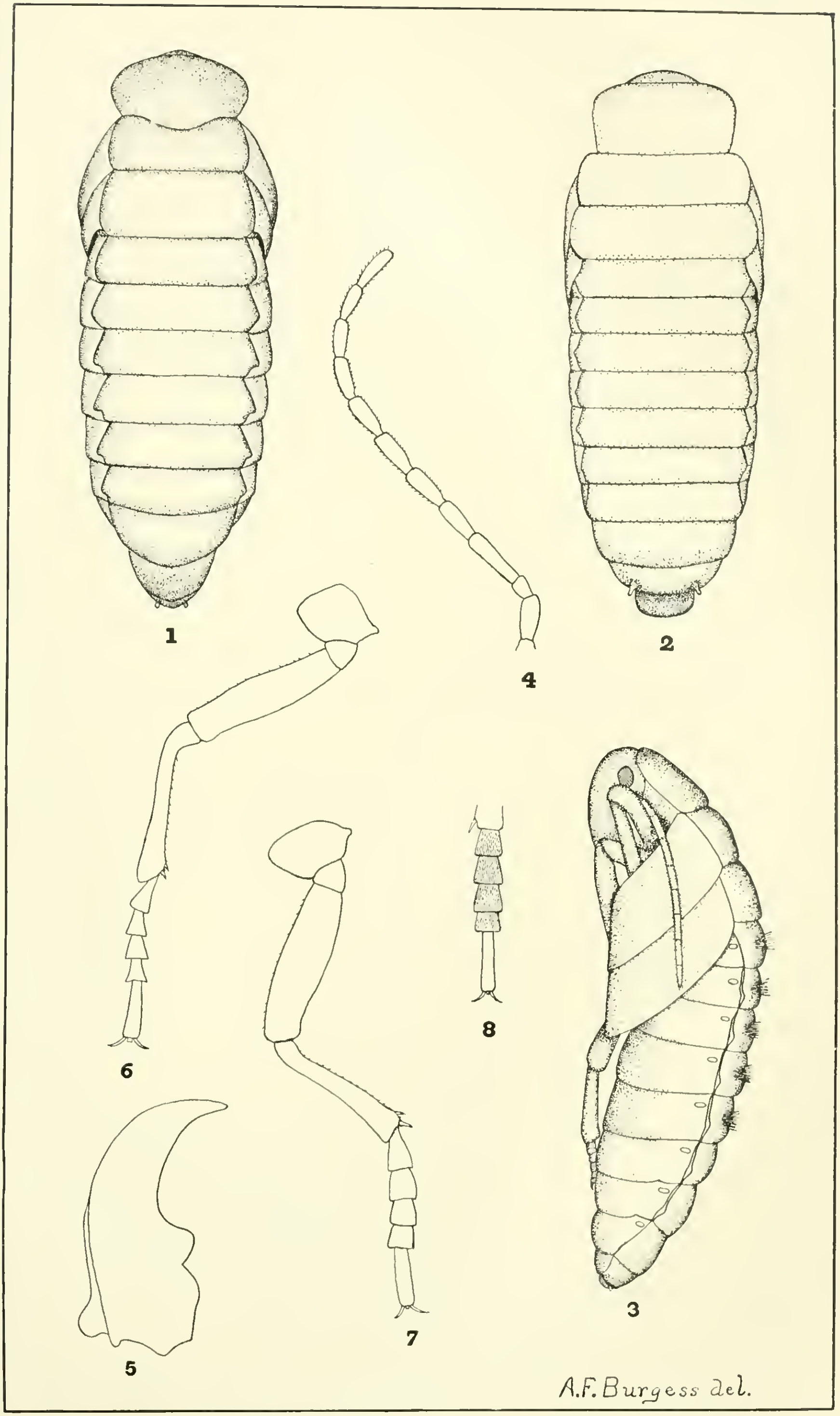
Plate 5.



SIXTH ANNUAL REPORT

OF THE

DAIRY BUREAU

OF THE

MASSACHUSETTS BOARD OF AGRICULTURE,

REQUIRED

UNDER CHAPTER 412, ACTS OF 1891.

JANUARY 15, 1897.

Dairy Bureau — 1896–97.

D. A. HORTON, Northampton, *Chairman.*
GEO. L. CLEMENCE, Southbridge.
J. L. ELLSWORTH, Worcester.

Executive Officer.

W. R. SESSIONS, *Secretary of the State Board of Agriculture.*

Assistant to the Secretary and Acting Executive Officer, appointed by the Governor.

GEO. M. WHITAKER, Boston.

REPORT OF THE DAIRY BUREAU.

To the Senate and House of Representatives of the Commonwealth of Massachusetts.

A change in the membership of the Bureau occurred early in the season by the retirement of Mr. C. L. Hartshorn, whose term as member of the Board of Agriculture expired in February. Mr. J. L. Ellsworth of Worcester, who succeeded Mr. Hartshorn as delegate to the Board from the Worcester Society, was appointed by the governor as a member of the Bureau. Mr. D. A. Horton was elected chairman of the Bureau, to succeed Mr. Hartshorn.

During the year the Bureau has had in its employ four agents. The duties of these agents are to ascertain how the dairy laws are obeyed, to obtain samples in case of suspected violations of law and to procure evidence for use in court when needed. The agents employed by the Bureau, and their terms of service, have been as follows: —

George F. Baldwin,	12 months.
Charles C. Scott,	9 months.
Fred M. Coffin,	4½ months.
J. W. Stockwell,	4½ months.

In addition, the Board has appointed as agents Dr. Charles Harrington, the Boston milk inspector, and his staff, to serve without compensation. This was done to quiet any legal quibbles as to the authority of the city inspector in certain contingencies, and to promote harmony and efficiency of action.

The active executive work of the Bureau has continued under the immediate charge and direction of George M. Whitaker, whose duties correspond somewhat to those of a

State Dairy Commissioner, but whose statutory title is vaguely defined as "Assistant to the secretary of the Board of Agriculture . . . to assist in the work prescribed in the eleventh section of this act."

The chemical work has been done by Dr. B. F. Davenport and the Hatch Experiment Station.

Oleomargarine.

The work of the Bureau in enforcing laws relative to imitation butter has been statistically as follows: —

Number of inspections,	1,949
Samples taken,	495
Cases in court,	76

The result of the court cases was as follows: —

Convictions,	50
Acquittals,	19
Nolle pros.,	6
Nolo contendere,	1
Total,	76

The complaints were made for the following causes: —

Serving oleomargarine in hotels and restaurants without giving notice,	30
Possession of imitation of yellow butter with intent to sell,	24
Sale of oleomargarine when butter was called for,	11
Lack of sign on wagon,	3
Interference with agents of the Bureau,	3
Selling imitation of yellow butter,	2
Failure to mark wrapper properly,	1
Failure to have local license,	1
Lack of proper sign in store,	1
Total,	76

These figures represent more convictions than last year, with fewer cases in court. If a person is disposed to violate the dairy laws, he usually breaks more than one, and we frequently find that in one transaction several statutes have been violated. For instance, one who sells oleomargarine when butter is called for will doubtless fail to have proper wrappers

and signs. Hence, the 76 cases noticed above probably represent more than twice that number of transgressions. But courts do not like to entertain more than one complaint based on a single transaction, and on account of past experiences we have been more conservative this year about basing several complaints on one sale or the taking of one sample, with the result that we have had, as stated above, fewer cases in court, but more convictions than last year. Of the cases appealed, all but one were settled before coming to trial by a plea of guilty; that one was lost on a technical ruling as to the meaning of the statute. This was a case for delivering oleomargarine from a wagon on which there was no sign.

Our work has been done outside of Boston, in which city Dr. Harrington continues his efficient work as the local milk inspector. His last published report shows 582 samples taken in Boston, and 106 cases in court, of which 71 were for serving oleomargarine in restaurants without notifying guests.

Statistics of court cases, however, do not adequately represent the result of work in enforcing laws. Police regulations are more for preventing crime than for its detection. And the nearly 2,000 inspections made by the agents of the Bureau in the principal towns and cities of the Commonwealth (outside of Boston) have had a healthy deterrent effect. As a result of this work, and the efforts of Dr. Harrington in the city of Boston, the sales of oleomargarine have materially decreased. The number of revenue taxes paid in Massachusetts has declined from 211 in 1891 to 28 in 1896. The receipts of oleomargarine reported at the Boston Chamber of Commerce were 13,552 packages in 1896, against 28,946 in 1895. Only 19 persons or corporations pay a revenue tax in this State at the present time. But 1 corporation pays a tax to do business (*i. e.*, to violate Massachusetts law) at 10 different locations, making the 28 noticed above. The action of this corporation speaks louder than words in proving the falsity of its own claim that oleomargarine "is an article of great food value," "sold only on its distinctive merits." This concern not only uses on its stationery the word "butterine" instead of "oleomargarine" for obvious reasons, but it prefers to sell an article colored in imitation of yellow butter,

rather than one which has a color of its own. For some reason it also prefers to use, as a part of its corporate title, the name of one of the distinctive dairy States of the union, though its place of business is Rhode Island.

In fact, all of the oleomargarine distributed in Massachusetts comes from Rhode Island, which is behind the other States of New England in pure food legislation. This oleomargarine is mostly sold by peddlers, and in a more or less deceptive way. We have found it under the seats of carryalls, in wagons with showy "washing-compound" signs, and in unsuspicious handle baskets. In fact, the tactics of these dealers are much like the methods of those who sell intoxicating liquors illegally. Evidence of sales under such circumstances is hard and often expensive to secure. The court cases which we have had lead us to the opinion that when the dealer knows — or thinks he knows — his customer, much of this oleomargarine is actually sold for butter.

Considerable oleomargarine is sold on "orders," the legal "sale" taking place in Rhode Island. We give below a copy of a letter sent by a Rhode Island concern to many of the grocers in Massachusetts. The letterhead announces that the concern deals in "fine creamery butterine."

We desire to inform you of the fact that all grocers in New England are now in a position to sell their customers butterine without a license, and that the demand for a fine quality of cream butterine is steadily increasing, and we take special pains to inform you how to sell this product and protect your trade against competitors who are now selling them, which will give your firm the profit we are certain you are entitled to. This effort we know will be appreciated by you, and we sincerely hope will develop a business that will pay us mutually to our satisfaction.

We enclose you herewith a supply of order blanks, which we request you to give to your solicitors or drivers of your delivery wagons, who will inform your customers of the opportunity to supply them with the finest cream butterine, and the solicitors may fill out the orders, when a sale is made, giving the customer's name, price he sells goods for per pound, and address of customer, trying, if possible, to accumulate orders for fifty pounds or more before forwarding to us, which we can send by freight or express at a much lower rate than in smaller lots.

We have given your firm the number which is on the "order blanks," and it is not necessary to write your name on orders.

The butterine is shipped to your customers in your care, and will be sent direct to you, and each package will be tagged to the customer it has been sold to; also we will forward you the bills for collection, and charge these parties under your number, and will expect you to remit for these goods as soon as bills are collected.

We will wrap each package with paper, so that you can deliver the same to customers without others being aware of its contents.

Our cream butterine is put up in 10, 20, 30, 50 and 60 pounds solid-packed tubs, and 10 pound cases of 1 pound brick prints, also 37 pound tubs of 1 pound bricks, which is "butter color," and we quote you the very low price of 12 cents per pound, F. O. B., Providence.

We will ship either by freight or express, as you request; and, as the profit on these goods is more than is made on butter, we know you will push it hard, and hope your commissions which we forward you each month will be quite large. Some of our "order agents" are making from $75 to $100 per month, and we do not doubt but that you will take care to see yours at that point; also we will say that if you desire to put a man on this work specially in your city we think he will make you money, as he should get from 15 to 23 cents per pound, which is a good profit over 12 cents F. O. B., Providence. We now await results.

In some instances the Commonwealth of Massachusetts is itself an evader of the law, if not an open violator of it. In the discussion in the Legislature last winter the friends of oleomargarine admitted that the Commonwealth itself is the greatest violator of the law, inasmuch as its agents annually buy large quantities of the article for use in State institutions. It was claimed that bills on file at the office of the State Auditor show that large quantities are used at the various State farms, almshouses, hospitals and other institutions. Some of the private charitable institutions also use this deceptive imitation, and in some instances even the veterans of the late war, who fought valiantly to preserve the Union and who find themselves in straightened circumstances in old age, are given this same product.

It may not be out of place briefly to re-state the arguments and facts on which these laws are based. The oleomargarine manufacturers and dealers keep up a constant agitation,

through the press and in other ways, which is of an absolutely misleading and dishonest nature. They continually call attention to the food value and healthfulness of oleomargarine, and quote what some "prominent medical man" says of its value. All this talk is deceptive. No one claims at this day that oleomargarine is unhealthful, though it is less digestible than butter. Its melting point is higher than the melting point of butter, and when taken into the stomach a higher degree of animal heat must be secured before the oleomargarine can be melted than is necessary to digest butter. This is an important fact in the case of persons of weak digestion. It is also a fact that, by reason of lacking the volatile oils which give butter its delicate taste, oleomargarine is less digestible than butter. The delicate and palatable flavors in food have a purpose in promoting the secretion of the salivary juices, and, so far as oleomargarine is lacking in these flavors, it is relatively less digestible than butter.

But the agitation for restrictive laws and their justification rests on other grounds. No one denies that suet and lard are harmless food fats and that under ordinary circumstances, if people desire to use them, they should be given an opportunity to do so. But when these fats are mixed and colored to imitate yellow butter, whatever may be the scientific food value of the product, as an article of commerce it is not sold on its merits but on account of the skill of the imitation. There is no demand for oleomargarine of a white color. The whole history of the trade is a history fraught with misrepresentation. Oleomargarine never has been put on the market and advertised on its merits for its distinctive food value. It has always been pushed on account of its similarity to butter. It is packed in butter tubs, it is colored with butter color, and of late years the trade has adopted the name "butterine," in preference to the older and more correct form, "oleomargarine." These facts are so self-evident, and the deceit is so palpable that it is recognized even by the paragraphers who manufacture the jokes for the humorous papers; and one of them represents a person asking his grocer how "b-u-t-t-e-r-i-n-e" is pronounced, and the answer is, "With the last syllable silent."

These laws are sometimes the subject of sneers, as "being

in the interests of the farmers," as if the agricultural element of the country was something hardly equal in importance with the rest of humanity. This is wrong, as we think that these laws are equally in the interests of consumers, honest merchants and the farmers. But, even placed on the latter basis, the magnitude of the dairy interests of the country is not generally appreciated, and is worthy of consideration. The chief of the National Dairy Bureau, Maj. H. E. Alvord, estimates that the annual value of the dairy product of the nation is $450,000,000. We have heard a great deal during the last few months about the relative value of gold and silver, but there has never been a year when the entire gold and silver product of the country was enough to buy the dairy products of this country the present year. These products at market rates would pay off all the State and county debts in the nation, and leave a handsome balance. As a matter of broad statesmanship and sound political economy, is it not wise to regulate the sale of imitations of these articles, and is it not equally proper that the degree of regulation should be proportioned to the degree of deceitfulness used in promoting their traffic?

Filled Cheese.

This is another imitation which has been of serious damage to the dairy interests of the country. The export demand for cheese from the United States has dwindled to almost nothing, while Canadian cheese has found an increasing sale every year in the foreign markets, where the words "American cheese" had come to be almost synonymous with deceit and cheating.

The evil became so great that during the year Congress has taken the matter in hand, and passed laws regulating the sale of lard cheese. Hence the business is much curtailed. Previous to this national legislation Massachusetts had laws on the subject which have proved satisfactory, as there has not been so much temptation to sell adulterated cheese as to sell imitation butter. Although the Bureau has made much effort to ascertain if any filled cheese was sold in Massachusetts, we have been unable to find any, and believe that the State is practically free from it.

Milk.

The Bureau has done more work in enforcing the milk laws during the past year than ever before, chiefly in response to requests from different localities, and in instances where the work could be done by an agent in connection with the work on oleomargarine cases, without additional expense.

We have had three cases in court for selling milk below the legal standard, and in all convictions were secured. The probabilities are that in each case the milk was actually adulterated. The analyses were in —

	Per Cent.	Per Cent.	Per Cent.
Case No. 1, ...	fat, 2.82;	solids not fat, 8.80;	total, 11.62
Case No. 2, ...	" 2.20;	" " " 7.20;	" 9.40
Case No. 3, ...	" 2.22;	" " " 8.38;	" 10.60
	" 1.66;	" " " 8.66;	" 10.32

We have taken during the year 139 samples of milk, of which the above 3 were all that were so far below the standard as to warrant bringing the case into court.

An interesting study in the milk question is furnished by the analyses of samples from different localities. In October an inspector was sent by request to Methuen, and samples were taken from 9 milkmen, analyzing as follows: —

	Per Cent.		Per Cent.
No. 1, ...	13.24	No. 7, ...	14.98
No. 2, ...	14.46	No. 8, ...	12.40
No. 3, ...	12.74	No. 9, ...	14.28
No. 4, ...	13.10	No. 10, ...	12.44
No. 5, ...	12.84	No. 11, ...	14.36
No. 6, ...	13.92		

At another time samples were taken from 6 milkmen in Greenfield, with the following results: —

	Per Cent.		Per Cent.
No. 1, ...	12.00	No. 4, ...	14.40
	14.20		12.56
No. 2, ...	13.64	No. 5, ...	13.20
No. 3, ...	12.38		12.36
	13.86	No. 6, ...	13.24

It will be noticed that in this town the practice of mixing milk does not probably exist to the extent that it should, as different milkmen were found with milk averaging all right, but of wide variation in quality.

Compare the above with the analyses of samples taken in Chelsea, as follows: —

	Per Cent.		Per Cent.
No. 1, ...	12.50	No. 5, ...	12.12
No. 2, ...	13.06	No. 6, ...	12.50
No. 3, ...	12.42	No. 7, ...	12.46
No. 4, ...	12.46		

The above samples from Chelsea were taken on the request of local parties, who suspected some milkmen of adulterating whole milk with skim-milk. The result of the analyses would indicate that something of this kind had been done, and yet the milk was not poor enough to run the risk of defeat in court.

It should be remembered that no complaint is made against a person for selling milk below the standard unless the milk varies enough from the statutory standard to make conviction seem reasonably sure. Many people who argue against the milk standard think that the statute draws an arbitrary line, and that anything which falls below that line, be the difference ever so small, may be the basis of a legal prosecution and cause the seller or producer to be branded as a criminal. Nothing of this kind exists, in actual practice. The milk must be enough below the standard to satisfy the court, beyond any reasonable doubt, that it is not of average quality, in spite of the efforts of shrewd lawyers on the defence to cast suspicion on methods of sampling or accuracy of the analysis.

This allowing a certain latitude is not favoritism, or laxity in enforcing the laws, — but it is due to well-established principles of court procedure which have the sanction of the highest legal lights in the Commonwealth, and which would soon cause trouble if they were violated.

The Legislature of last winter improved the milk laws by specifying the amount of fat and of solids not fat which standard miik should contain. This put a stop to the excessive use of skim-milk as an adulterant.

The law was also amended, reducing the standard during

three additional months in the year. This we fear was a mistake, and we hope no further reductions will be made. We think that the interests of both consumer and producer are promoted by the 13 per cent standard.

Condensed Milk and Cream.

The sale of condensed milk is increasing, as it is sold in convenient form for many to use. The use of cream is also increasing rapidly. Not only is it delivered by milkmen, but it is becoming a staple article of merchandise in many stores. This condensed milk and cream can be brought from greater distances than the ordinary sale milk, and is proving in some cases a formidable competitor to the milk business. The quality of condensed milk and cream varies to a remarkable degree, and a statute standard may soon be necessary, for the protection of both consumer and producer. A brand of "evaporated cream" was found by an agent of the Bureau with only 3.75 per cent of fat. Condensed skim-milk would be a more honest name.

Other Questionable Practices.

Several new forms of milk preservatives have been advertised quite extensively during the past year, and great efforts made to induce milk dealers and farmers to buy them. One claim made for one of these preservatives was that after having been added to the milk it would evaporate so that no chemist could detect it, and still retain enough of its qualities to preserve the milk. Several samples of milk treated with this preservative were sent to our chemist without any notification of the fact of a preservative having been used, but in every instance he discovered it, and so reported.

Several new processes of renovating old butter have been perfected during the past few years, and we find upon the market considerable of what is known as "process butter." Samples of this have been taken for analysis a number of times, and in every instance we have found that it was unquestionably the product of the cow's udder; but such butter should be sold for what it is, and not palmed off upon customers as fresh creamery. The same remark would apply to many of the ladle packed goods.

Boston Milk.

The executive officer of the Bureau has given some time and attention during the year to the interests of the Milk Producers' Union, believing that such a course was in accordance with the statute which says that the Dairy Bureau is established "to promote the improvement of the products of the dairy," "to investigate all dairy products and imitation dairy products bought or sold within the Commonwealth," and "to disseminate such information as shall be of service in producing a more uniform dairy product, of higher grade and better quality." The milk receipts in the city of Boston have been phenomenally large during the past year, having increased about one million of the eight and one-half quart cans over the previous year, while the sales have not shown any great increase. The result has been an unusually large surplus, which has made the production of milk less satisfactory than in previous years. The statistics of the Boston milk business are as follows (the figures refer to eight and one-half quart cans) : —

	Receipts.	Sales.	Surplus.
1895, ...	9,856,500	8,040,732	1,815,768
1894, ...	9,705,447	7,657,421	2,048,026
1893, ...	9,263,487	7,619,722	1,643,765
1892, ...	9,212,667	7,315,135	–

Months.	Receipts.	Sales.	Surplus.
1896.			
January, ...	844,709	651,827	192,882
February, ...	808,383	611,793	196,590
March, ...	871,572	657,038	214,534
April, ...	891,275	672,561	218,714
May, ...	1,005,115	696,599	308,516
June, ...	994,817	675,796	319,021
July, ...	899,397	712,188	187,209
August, ...	854,913	687,224	167,689
September, ...	866,691	635,092	231,599
October, ...	960,734	699,245	261,489
November, ...	885,903	690,920	194,983
December, ...	898,599	707,095	191,504
Totals, ...	10,772,108	8,087,378	2,684,730

Dairy Exhibitions.

The country meeting of the State Board of Agriculture gave more than ordinary prominence to dairy matters, and in connection with the exhibition there was a State butter show, under the management of the Bureau. The exhibition was of excellent quality, and brought many high compliments from the expert judges — Messrs. E. A. Hovey and Orrin Douglas of Boston. It showed conclusively that, though Massachusetts may not be a distinctively agricultural State, so far as quantity of farm products is concerned, she can hold her own with the best in quality. The highest score was on a par with the highest scores at the State dairy exhibitions in Vermont and New Hampshire, and was three points more than the highest score in Maine. In connection with the meeting an explanation of the enforcement of the law relative to the milk standard was given, and a number of samples of milk were tested.

The following is the official score of the butter at this exhibition : —

Private Dairies.

	Flavor.	Texture.	Color.	Salt.	Style.	Total.
L. F. & W. H. Gray, Ashfield, first premium, ...	43	25	14.75	10	5	97.75
H. C. Haskell, East Deerfield, second premium, . .	39	25	15	10	5	94
F. W. Trow, Buckland,* .	39	25	15	10	5	94
J. M. Harris, East Northfield, third premium, . . .	39	25	14.75	10	5	93.75
Henry Lively, Hawley, . .	40	25	14	10	4.5	93.50
C. A. Wiley, Buckland, . .	40	24.5	14	10	5	93.50
H W. Blair, North Blandford,	38	25	15	10	5	93
J. G. Pickett, Greenfield, .	38	25	14.75	10	5	92.75
Mrs. S. C. Severance, Leyden,	38	25	14	10	5	92
W. H. Laws, Fitchburg, .	37	25	15	10	5	92
C. A. Wiley, Buckland, . .	37	25	14.50	10	5	91.50
D. H. Clark, Easthampton, .	36	25	14.75	10	5	90.75
C. B. Lyman, Southampton, .	36	25	14.50	10	5	90.50
Winslow S. Lincoln, Worcester, ...	37	23.5	14.75	10	5	90.25
J. B. & H. H. Warriner, Hawley, ...	35	25	14.50	10	4.75	89.25
J. L. Brewer, Pelham, . .	33	25	15	10	5	88
Mrs. C. W. Hillman, Colrain,	32	25	15	10	5	87
H. H. Leach, ...	35	22	14	10	5	86
Francis Howland, Conway, .	30	25	15	10	5	85
C. A. Merriam, New Salem, .	30	25	15	10	4	84

* This was received after the others had been scored and the premiums announced.

Creameries.

	Flavor.	Texture.	Color.	Salt.	Style.	Total.
1. Hillside, Windsor, Vt., .	42.50	25	15	10	5	97.50
2. Hinsdale, first premium,	42.50	25	14.75	10	5	97.25
3. Hillside prints, . .	41	25	15	10	5	96
4. Shelburne Falls, second premium, . . .	40.50	25	15	10	5	95.50
5. New Salem, third premium, ...	40.25	25	15	10	5	95.25
6. Chester, ...	40	25	15	10	5	95
7. Montague, . . .	40.50	25	14.50	10	5	95
8. Conway, . . .	40	24	15	10	5	94
9. Northfield, . . .	39	25	15	10	5	94
10. Heath, ...	38	25	14.50	10	5	92.50
11. Amherst, . . .	38	25	14.25	10	5	92.25
12. Coldspring, . . .	37	25	15	10	5	92
13. Charlemont, . . .	34	25	15	10	5	89
14. Ipswich, ...	32	25	14	10	4	85
15. Ashfield,* . . .	–	–	–	–	–	–

* Received too late for scoring.

Fair Tests.

The executive officer of the Bureau has been called upon twice to take charge of the dairy premiums at agricultural fairs, where the prize was offered for the greatest amount of butter fat produced on the fair grounds during the exhibition. This form of test is very practical, and is growing in popularity. The value of a butter cow consists in what she will produce, and there is no better way of ascertaining this than by an actual test of the milk. This method of testing cows for the premiums of the agricultural societies is a marked step in advance of the old-time way. At one of the fairs, the Berkshire, the entries were not enough to call for any test being made. At the fair of the Worcester South Society tests were made of the product of the competing animals for one day, with the following result, the two rows of figures being the weight and test of the evening and morning milking: —

OWNER.	Weight of Milk.	Per Cent of Fat.	Weight of Fat.	Total (Pounds).
	Pounds.		Pounds.	
Luther Crawford, New Braintree, grade Guernsey.	13.75	4.6	.63	–
	16.16	4.2	.68	–
	29.91			1.31
C. Underwood, East Brookfield, Guernsey Belle.	14.62	5.4	.79	–
	10.40	4.6	.48	–
	25.02			1.27
Luther Crawford, New Braintree, thoroughbred Jersey.	11.12	6.8	.76	–
	10.06	5.0	.50	–
	21.18			1.26
O. W. Wilson, Spencer, ...	14.81	3.8	.56	–
	18.50	3.2	.59	–
	33.31			1.15
Luther Crawford, New Braintree, grade Jersey.	12.37	4.4	.54	–
	14.75	4.0	.59	–
	27.12			1.13
Melvin Shepard, Sturbridge, . . .	13.68	4.2	.57	–
	11.70	4.8	.56	–
	25.38			1.13
L. W. Woodis, North Brookfield, No. 9,	15.62	3.4	.53	–
	18.00	3.2	.58	–
	33.62			1.11
Henry F. Freeman, Warren, . . .	15.37	3.6	.55	–
	16.40	3.2	.53	–
	31.77			1.08
C. D. Richardson, West Brookfield, .	6.25	4.6	.29	–
	10.75	5.4	.58	–
	17.00			.87
C. L. Underwood, East Brookfield, Bessie, 3d.	8.06	6.0	.48	–
	7.87	4.4	.35	–
	15.93			.83
L. W. Woodis, North Brookfield, No. 8,	5.75	3.8	.22	–
	10.62	3.2	.34	–
	16.37			.56

Much of an improvement as is this method of getting at the merits of animals, it is open to the objection that animals which have been taken from their stalls, driven to the fair grounds and subjected to unnatural conditions and surroundings, may not do their best. If the production of milk is, as is believed by the best experts to-day, closely allied with the nervous temperament and system, then anything which disturbs that will have a deleterious effect upon the quality of milk. Consequently, the ideal way of testing milch cows is at the barn of the owner, where the cows are under perfectly normal and usual conditions. This test, while satisfactory to the student of dairy problems, has nothing spectacular which would draw a crowd to a cattle show, and hence, if generally undertaken by agricultural societies, must be for purely educational purposes, rather than from any motive of securing a popular "attraction." One such test has been made during the past year by the officer of the Bureau, for the Bay State Agricultural Society. The herd tested was that of Mr. Atherton Brown of Brookline. The test occupied two days and each of the four rows of figures represents one milking. The animals are registered Jerseys.

NAME OF COW.	Pounds of Milk.	Test.	Pounds of Fat.	Total (Pounds).
Celetta,	15.56	5.2	.809	–
	17.44	5.2	.906	–
	16.06	5.0	.803	–
	18.31	5.4	.988	–
	67.37	5.2		3.506
Fleuriste,	14.56	5.6	.815	–
	16.19	5.6	.906	–
	13.44	5.8	.779	–
	16.19	6.0	.971	–
	60.38	5.75		3.471
Young Clementine,	14.50	4.6	.667	–
	17.00	5.4	.918	–
	12.50	5.4	.675	–
	15.38	5.4	.830	–
	59.38	5.2		3.090

NAME OF COW.	Pounds of Milk.	Test.	Pounds of Fat.	Total (Pounds).
Miramas, Hebe,	15.38	4.6	.705	–
	14.94	5.3	.776	–
	12.63	5.4	.682	–
	15.50	5.4	.837	–
	58.45	5.15		3.000
Pedrissa,	12.19	6.0	.731	–
	12.44	6.0	.746	–
	11.38	6.0	.688	–
	13.31	6.0	.798	–
	49.32	6.0		2.963
Total for herd,	. .	. .	. .	16.030

Dairy Meetings.

The educational work done by the Bureau during the past year has been chiefly at such meetings as the acting executive officer could personally attend, thus carrying on this portion of our work at a minimum of draft upon our appropriation. Thirty-six dairy meetings have been held under the auspices of the Bureau, of which he has addressed thirty-two. Other speakers who have been employed for one or more meetings are Mr. George L. Clemence and Mr. J. L. Ellsworth of the Bureau, Dr. S. W. Abbott, secretary of the Board of Health, Dr. J. B. Lindsey of the Hatch Experiment Station, and Mr. Charles A. Dennen of the Cattle Commission. The comprehensive language of the statute quoted above enables dairy meetings to be held in connection with farmers' clubs, granges, and at other places which could not be reached by the regular institutes of the incorporated societies. Most of these meetings during the past year were conducted with charts, blackboards, milk tester, maps and other object-lesson paraphernalia, and, so far as could be ascertained, the meetings were well received.

In connection with these meetings and with the general work of the Bureau I have tested several hundred samples of milk with the Babcock tester. I have been also called to

represent the dairy interests of the State at the meeting of the Connecticut Dairymen's Association at Hartford, the New Hampshire Board of Agriculture at the Weirs, and the National Dairy Union at Chicago. I also responded to an invitation to address a committee of the Rhode Island Legislature on oleomargarine legislation, the laws of Massachusetts and their enforcement.

During the past year a compilation of the laws of the State, with the court decisions thereon, has been prepared and published.

Suggestions.

We continue of the opinion that the cause of honest and wholesome dairy products would be enhanced by what seems to us would be a better division of labor between this department and the Board of Health. It seems to us that the Board of Health ought not to be hampered by restrictive legislation compelling it to expend a prescribed proportion of its appropriation in the prosecution of commercial frauds, particularly in view of the fact that the healthfulness of the State's milk supply is being considered more than ever before, that the great advances recently made in bacteriology have given definite data to start with, and that there seems a call from all parts of the State, noticeable at meetings of medical associations, for an increased amount of work from the health stand-point. If the labor could be divided so that the Board of Health were free to do increased work along the line which its name naturally suggests, while the detection of commercial frauds was in the hands of this Bureau, we believe that great good would result.

Our experience this year has brought to our attention the fact that the size of the fines in oleomargarine cases places them beyond the jurisdiction of trial justices. By a special act their authority has been extended to include milk cases, and we suggest that this statute be broadened so as to include all dairy products and imitations thereof.

Finances.

The following is the manner in which the appropriation of $7,000 has been expended during the past year: —

Appropriation by Legislature of 1896,		$7,000 00
Members of the Bureau, travelling expenses and attending meetings,	$397 35	
George M. Whitaker, travelling and office expenses, supplies, etc.,	834 65	
Agents' salaries,	1,937 62	
Agents' expenses,	2,095 32	
Chemists,	1,299 00	
Educational work,	285 27	
Printing,	149 54	
	$6,998 75	
Unexpended,	1 25	
		$7,000 00

Respectfully submitted,

GEORGE M. WHITAKER,
Acting Executive Officer.

Approved and adopted as the report of the Dairy Bureau.

D. A. HORTON,
GEO. L. CLEMENCE,
J. L. ELLSWORTH.

BOSTON, Jan. 15, 1897.

FINANCIAL RETURNS

AND

ANALYSES OF PREMIUMS AND GRATUITIES

OF THE

INCORPORATED SOCIETIES,

WITH MEMBERSHIP AND INSTITUTES

FOR THE YEAR 1896.

Returns of Societies.

AMESBURY AND SALISBURY AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1881, Acts of 1881, chapter 204.

Originally raised by contribution, $1,002.32; now has $8,005.89 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $8,156.33: real estate, $7,735.44; crockery, tables, etc., $269.89; bills due and unpaid, $75; cash on hand, $76. Total liabilities consist of notes to the amount of $1,900. Receipts in 1896, $2,703.40: bounty, $600; new members, $20; donations, $84.35; other sources, $1,998.95. Expenditures in 1896, $2,627.40: premiums and gratuities paid, $974.80; current running expenses, $140.52; interest, $114; other expenses, $1,398.08. The society offered $1,800 in premiums, and awarded and paid $974.80 in premiums and gratuities, which went to 23 cities and towns. One hundred and eighty-two dollars and ninety cents went to 6 cities and towns outside the State. Four hundred and seventeen persons received premiums and 190 gratuities. Under head of farms $23 was awarded and paid; under farm and pet stock $488.50 was awarded and paid; under farm and garden products $152.10 was awarded and paid; under dairy products $4.25 was awarded and paid; under domestic manufactures $117.35 was awarded and paid; under agricultural implements $6 was awarded and paid; under objects strictly agricultural, not specified, $45 was awarded and paid; under objects other than agricultural, not specified, $138.60 was awarded and paid. The society reports 237 members, — 207 males and 30 females. Four farmers' institutes were held: at Amesbury, January 15, on "Birds and the benefit they are to the farmer," and "Salt hays, meadow or swamp hay, and average upland hay; their comparative values and how to feed them;" at Newbury, February 20, on "Rural and farm law" and "Salt hays,

meadow or swamp hay, and average upland hay: their comparative values and how to feed them;" at Amesbury, March 13, on "Farm crops" and "Obstacles to successful farming and how to overcome them;" and at Amesbury, December 2, on "Poultry culture as a calling."

BARNSTABLE COUNTY AGRICULTURAL SOCIETY.

Incorporated 1844, Acts of 1844, Chapter 114.

The society in its first report to the Board in 1853 reported the amount of its permanent fund (par value) to be $1,740; now has $8,300 invested as a capital stock in real estate and bonds. Total assets, $8,447.41: real estate, $7,500; bonds, $800; cash on hand, $147.41. Total liabilities, $3,837.80: notes, $3,550; outstanding bills, $287.80. Receipts in 1896, $2,719.23: bounty, $600; other sources, $2,119.23. Expenditures in 1896, $2,829.95: premiums and gratuities paid, $1,894.95; current running expenses, $935. The society offered $2,395 in premiums, and awarded and paid $1,894.95* in premiums and gratuities, which went to 13 cities and towns. Ninety persons received premiums and 95 gratuities. Under head of farm and pet stock $370.85 was awarded and paid; under field and garden crops $5 was awarded and paid; under farm and garden products $239.85 was awarded and paid; under dairy products $10 was awarded and paid; under domestic manufactures $138.25 was awarded and paid; under objects strictly agricultural, not specified, $26 was awarded and paid; under trotting $985 was paid; under objects other than agricultural, not specified, $20 was awarded and paid. The society reports 584 members, — 355 males and 229 females. Three farmers' institutes were held: at East Sandwich, January 16, on "Salt hays, meadow or swamp hay, and average upland hay; their comparative values and how to feed them;" at Yarmouthport, February 21, on "Beautiful homes;" and at Barnstable, November 28, on "Management of agricultural fairs."

* Of this amount, $985 was paid for trotting.

BERKSHIRE AGRICULTURAL SOCIETY.

Incorporated 1811, Acts of 1811, Chapter 70.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be $3,000; now has $12,000 invested as a capital stock in real estate. Total assets, $12,685.98: real estate, $12,000; crockery, tables, etc., $200; bills due and unpaid, $334.33; cash on hand, $151.65. Total liabilities, $6,458.38: premiums due and unpaid, $120; outstanding bills, $1,338.38; mortgages or like liabilities, $5,000. Receipts in 1896, $6,726.29: bounty, $600; new members, $78; other sources, $6,048.29. Expenditures in 1896, $6,680.97: premiums and gratuities paid, $1,198.02; current running expenses, $4,115.51; interest, $188.95; other expenses, $1,178.49. The society offered $1,713.15 in premiums, awarded $1,318.02 in premiums and gratuities and paid $1,198.02, which went to 27 cities and towns. Eighteen dollars and fifty cents went to 2 towns outside the State. Two hundred and ten persons received premiums and 153 gratuities. Under head of farms $13 was awarded and paid; under farm and pet stock $660.46 was awarded and $553.46 paid; under farm and garden products $234 was awarded and $222 paid: under dairy products $24 was awarded and $23 paid; under domestic manufactures $228 was awarded and paid; under trotting $1,502.50 was paid; under objects other than agricultural, not specified, $64 was awarded and paid. The society reports 984 members, — 873 males and 111 females. Three farmers' institutes were held: at Hinsdale, January 16, on the "Babcock test *v.* the 'Space' system in Massachusetts creameries, which is better for the farmer?" at Lee, March 26, on "The Atlanta Exposition and the Farmers' National Congress: what I saw and heard there" and "What we know of stable manures;" and at Dalton, December 29, on "Winter care of milch cows."

BLACKSTONE VALLEY AGRICULTURAL SOCIETY.

Incorporated 1884, Acts of 1884, chapter 48.

Originally raised by contribution, $3,000; now has $4,500 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $4,651.74: real estate, $4,400; crockery, tables, etc., $100; cash on hand, $151.74. Total liabilities consist of mortgages or like liabilities to the amount of $1,600. Receipts in 1896, $1,705.76: bounty, $600; new members, $24; donations, $24.65; other sources, $1,057.11. Expenditures in 1896, $1,702.78: premiums and gratuities paid, $681.45; current running expenses, $1,021.33. The society offered $950 in premiums, and awarded and paid $681.45 in premiums and gratuities, which went to 16 cities and towns. Seven dollars and forty-five cents went to 3 cities and towns outside the State. One hundred and thirty persons received premiums and 33 gratuities. Under head of farms $88 was awarded and paid; under farm and pet stock $381.50 was awarded and paid; under field and garden crops $21.50 was awarded and paid; under farm and garden products $44.95 was awarded and paid; under dairy products $3 was awarded and paid; under domestic manufactures $28.75 was awarded and paid; under trotting $40 was awarded and paid; under objects other than agricultural, not specified, $62.10 was awarded and paid. The society reports 515 members, — 290 males and 225 females. Three farmers' institutes were held: at Uxbridge, March 6, on "Small fruits for the farm" and "Poultry for profit;" at Uxbridge, March 17, on "Management of agricultural fairs;" and at Mendon, March 25, on "Manures and fertilizers, and their use" and "The cultivation of flowers."

BRISTOL COUNTY AGRICULTURAL SOCIETY.

Incorporated 1823, Acts of 1823, chapter 32.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be $3,240; now has $32,000 invested as a capital stock in real estate. Total assets, $33,906.73: real estate, $32,000; crockery, tables, etc., $200; cash on hand, $1,706.73. Total liabilities, $13,093.01: outstanding bills, $93.01;

mortgages or like liabilities, $13,000. Receipts in 1896, $19,905.73: bounty, $600; new members, $100; other sources, $19,205.73. Expenditures in 1896, $20,901.65: premiums and gratuities paid, $9,636.74; current running expenses, $7,079.38; interest, $702.50; other expenses, $3,483.03. The society offered in premiums $11,129, awarded $9,729.75 in premiums and gratuities and paid $9,636.74,* which went to 49 cities and towns. One thousand nine hundred and four dollars and sixty cents went to 11 cities and towns outside the State. Nine hundred and four persons received premiums and 29 gratuities. Under head of farms $54 was awarded and paid; under farm and pet stock $1,380.75 was awarded and $1,333.75 paid; under field and garden crops $80 was awarded and paid; under farm and garden products $349.50 was awarded and $346.50 paid; under dairy products $41.75 was awarded and paid; under domestic manufactures $314.90 was awarded and $281.89 paid; under agricultural implements $10 was awarded; under trotting $7,000 was paid; under objects other than agricultural, not specified, $498.85 was awarded and paid. The society reports 875 members, — 675 males and 200 females. Four farmers' institutes were held: at Seekonk, February 14, on "The farm, its products and profits;" at Norton, March 17, on "Fruit culture;" at New Bedford, March 20, on "Perfect feed" and "The gypsy moth;" and at Foxborough, April 15, on "Fruit culture" and "The gypsy moth."

DEERFIELD VALLEY AGRICULTURAL SOCIETY.

Incorporated 1871, Acts of 1871, chapter 208.

Originally raised by contribution, $4,094.01; now has $9,200 invested as a capital stock in real estate. Total assets, $9,531.14: real estate, $9,200; crockery, tables, etc., $250; cash on hand, $81.14. Liabilities consist of mortgages or like liabilities to the amount of $800. Receipts in 1896, $2,307.56: bounty, $600; new members, $15; donations, $19.68; other sources, $1,672.88. Expenditures in 1896, $2,158.80: premiums paid, $1,149.99; current running expenses, $955.05; interest, $53.76. The society

* Of this amount, $7,000 was paid for trotting.

offered $1,436.25 in premiums, awarded $1,169.67 and paid $1,149.99,* which went to 27 cities and towns. Four dollars and thirty-five cents went to 1 city and 1 town outside the State. Two hundred and thirty-four persons received premiums. Under head of farm and pet stock $538.75 was awarded and $528.75 paid; under farm and garden products $65.72 was awarded and $60.82 paid; under dairy products $24 was awarded and $23 paid; under domestic manufactures $87.70 was awarded and $86.05 paid; under trotting $400 was paid; under objects other than agricultural, not specified, $53.50 was awarded and $51.37 paid. The society reports 1,084 members, — 843 males and 241 females. Three farmers' institutes were held: at Charlemont, January 25, on "Tuberculosis;" at Ashfield, February 15, on "The horse's foot, care and diseases," and "Japan; its farms and farmers;" and at Buckland, December 16, on "Economic summer and winter feed for milch cows."

EASTERN HAMPDEN AGRICULTURAL SOCIETY.

Incorporated 1856, Acts of 1856, chapter 156.

Originally raised by contribution, $3,000; now has $7,000 invested as a capital stock in real estate. Total assets, $7,053.25: real estate, $7,000; bills due and unpaid, $51; cash on hand, $2.25. Total liabilities, $3,920.51: outstanding bills, $861.60; mortgages or like liabilities, $3,059.56. Receipts in 1896, $2,110.73: bounty, $600; new members, $40; donations, $63.51; other sources, $1,407.22. Expenditures in 1896, $2,110.73: premiums and gratuities paid, $1,748.85; other expenses, $745.91. The society offered $2,426.75 in premiums, and awarded and paid $1,748.85 † in premiums and gratuities, which went to 21 cities and towns. One hundred and thirty-five persons received premiums and gratuities. Under head of farms $10 was awarded and paid; under farm and pet stock $668.75 was awarded and paid; under farm and garden products $161.80 was awarded and paid; under dairy products $7 was awarded and paid; under domestic manufactures $56.30 was awarded and paid; under trotting $830 was paid; under

* Of this amount, $400 was paid for trotting.

† Of this amount, $830 was paid for trotting.

objects other than agricultural, not specified, $7 was awarded and paid. Three farmers' institutes were held: at Palmer, January 14, on "How to feed the dairy cow for milk and cream production;" at Palmer, February 11, on "Our forests;" and at Monson, March 10, on "Beautiful homes."

ESSEX AGRICULTURAL SOCIETY.

Incorporated 1818, Acts of 1818, chapter 25.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be $9,363.66; now has $29,500 invested as a capital stock in real estate, notes, stocks, crockery, tables, etc. Total assets, $29,500: real estate, $14,300; notes, $1,000; stocks, $14,000; crockery, tables, etc., $200. Total liabilities consist of notes and overdraft to the amount of $10,272.88. Receipts in 1896, $11,952.31: bounty, $600; notes, $54.10; stocks, $869.25; new members, $180; donations, $86.25; other sources, $10,162.71. Expenditures in 1896, $11,675.81: premiums paid, $1,121; current running expenses, $745.87; interest, 577.42; other expenses, $9,231.52. The society offered $2,369.50 in premiums, awarded $1,121* and paid $1,034.75,* which went to 29 cities and towns. Three hundred and eighty-four persons received premiums. Under head of farms $59 was awarded and $66 paid; under farm and pet stock $466 was awarded and $354 paid; under field and garden crops $79 was awarded and $91 paid; under farm and garden products $369.50 was awarded and $308.50 paid; under dairy products $8 was awarded; under domestic manufactures $132.50 was awarded and $133.25 paid; under agricultural implements $47 was awarded and $30 paid; under objects strictly agricultural, not specified, $35 was awarded; under objects other than agricultural, not specified, $66.50 was awarded and $67.75 paid. The society reports 1,477 members, — 1,460 males and 17 females. Five farmers' institutes were held: at Haverhill, January 10, on "The feed and care of the farmer's household," and "Rural and farm law;" at Salem, February 7, on "Advanced methods of feeding cattle" and "The war against the gypsy

* Amounts paid for 1895; awarded for 1896.

moth;" at Newburyport, March 6, on "Fruit;" at Beverly, April 3, on "Infectious diseases of domestic animals, their causation and prevention;" and at Beverly, December 18, on "The production of milk" and "Management of a dairy farm."

FRANKLIN COUNTY AGRICULTURAL SOCIETY

Incorporated 1850, Acts of 1850, chapter 104.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be $3,768; now has $9,095 invested as a capital stock in real estate, stocks, crockery, tables, etc. Total assets, $9,310.82: real estate, $8,000; stocks, $1,020; crockery, tables, etc., $75; bills due and unpaid, $68.41; cash on hand, $147.41. Total liabilities, $2,517.07: outstanding bills, $417.07; mortgages or like liabilities, $2,100. Receipts in 1896, $4,171.21: bounty, $600; stocks, $20; new members, $22.50; donations, $5; other sources, $3,523.71. Expenditures in 1896, $4,023.80: premiums and gratuities paid, $1,216.90; current running expenses, $2,056.43; interest, $32.88; other expenses, $717.59. The society offered $1,946 in premiums, awarded $1,256.50 in premiums and gratuities, and paid $1,216.90, which went to 22 cities and towns. Four dollars and fifty cents went to 1 town outside the State. Three hundred and forty-one persons received premiums and 14 gratuities. Under head of farm and pet stock $872.25 was awarded and $858.25 paid; under farm and garden products $198.50 was awarded and $189.65 paid; under dairy products $23 was awarded and paid; under domestic manufactures $130.75 was awarded and $116 paid; under objects strictly agricultural, not specified, $17 was awarded and $15 paid; under trotting $830 was paid; under objects other than agricultural, not specified, $15 was awarded and paid. The society reports about 1,800 members, — about 1,500 males and about 300 females. Three farmers' institutes were held: at Greenfield, January 4, on "Tuberculosis;" at Greenfield, January 27, on "An hour with the weather man;" and at Montague, February 27, on "The Atlanta Exposition and the Farmers' National Congress: what I saw and heard there" and "Co-operation among farmers."

HAMPDEN AGRICULTURAL SOCIETY.

Incorporated 1844, Acts of 1844, chapter 56.

This society made no returns to the Board of Agriculture for the year 1896.

HAMPSHIRE AGRICULTURAL SOCIETY.

Incorporated 1814, Acts of 1814, chapter 19.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be $3,255.26; now has $4,352.43 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $4,352.43: real estate, $4,200; crockery, tables, etc., $152.43. Total liabilities, $1,031.94: outstanding bills, $131.94; mortgages or like liabilities, $900. Receipts in 1896, $1,971.92: bounty, $600; new members, $40; donations, $79.88; other sources, $1,252.04. Expenditures in 1896, $2,036.86: premiums and gratuities paid, $554.60; current running expenses, $577.31; interest, $54.95; other expenses, $850. The society offered $799 in premiums, and awarded and paid $554.60 in premiums and gratuities, which went to 16 cities and towns. Ninety-four persons received premiums and 4 gratuities. Under head of farm and pet stock $262.50 was awarded and paid; under field and garden crops $31 was awarded and paid: under farm and garden products $117.50 was awarded and paid; under dairy products $5 was awarded and paid; under domestic manufactures $32.85 was awarded and paid; under objects strictly agricultural, not specified, $75 was awarded and paid; under trotting $600 was paid; under objects other than agricultural, not specified, $28.75 was awarded and paid. The society reports 752 members, 530 males and 222 females. Four farmers' institutes were held: at Amherst, January 18, on "How to keep the boys on the farm" and "How to conduct agricultural fairs;" at Hadley, January 30, on "Rational systems of feeding dairy stock, in connection with a discussion of some new forage crops" and "Small fruits, their culture and variety;" at Belchertown, February 27, on "How to keep the boys on the farm," "Variations in the quality of milk" and "How

to feed the dairy cow for milk and cream production;" and at Amherst, December 30, on "The usefulness of the Board of Agriculture."

HAMPSHIRE, FRANKLIN AND HAMPDEN AGRICULTURAL SOCIETY.

Incorporated 1818, Acts of 1818, chapter 125.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be $8,141.29; now has $3,090.38 invested as a capital stock in personal property. Total assets, $3,138.46: real estate lease, $1,600; bank funds, $618; crockery, tables, etc., $638; bills due and unpaid, $55; cash, $227.46. Total liabilities, $149.50: premiums due and unpaid, $94.50; outstanding bills, $55. Receipts in 1896, $3,046.45: bounty, $600; bank funds, $18.12; new members, $69; other sources, $3,046.45. Expenditures in 1896, $3,604.56: premiums and gratuities paid, $789.25; current running expenses, $2,694.31; other expenses, $121. The society offered $1,232.20 in premiums, awarded $883.75 in premiums and gratuities and paid $789.25, which went to 24 cities and towns. One hundred and sixty-six persons received premiums and 22 gratuities. Under head of farm and pet stock $600.70 was awarded and $548.45 paid; under field and garden crops $29 was awarded and paid; under farm and garden products $139.50 was awarded and $124.50 paid; under dairy products $18 was awarded and paid; under domestic manufactures $52.30 was awarded and $43.05 paid; under agricultural implements $10 was awarded and $7 paid; under trotting $702.50 was paid; under objects other than agricultural, not specified, $34.25 was awarded and $19.25 paid. The society reports 1,005 members, — 757 males and 248 females. Four farmers' institutes were held: at Northampton, January 1, on "The Atlanta Exposition and Farmers' National Congress: what I saw and heard there;" at Hadley, January 30, on "Rational systems of feeding dairy stock, in connection with a discussion of some new forage crops" and "Small fruits, their culture and variety;" at Easthampton, February 20, on "Dairying" and "Climatic influence on crops;"

and at Northampton, March 26, on "Rural and farm law" and "How plants take their nitrogen, and what they do with it."

HIGHLAND AGRICULTURAL SOCIETY.

Incorporated 1859, Acts of 1859, chapter 145.

Originally raised by contribution, $3,262; now has $3,150 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $3,219.72: real estate, $3,000; crockery, tables, etc., $150; cash, $69.72. Receipts in 1896, $1,572.97: bounty, $600; new members, $22; other sources, $950.97. Expenditures in 1896, $1,503.25: premiums paid, $683.15; current running expenses, $816.14; interest, $3.96. The society offered $793.55 in premiums, and awarded and paid $683.15,* which went to 23 cities and towns. One hundred and eighty persons received premiums. Under head of farm and pet stock $411 was awarded and paid; under field and garden crops $21 was awarded and paid; under farm and garden products $37.30 was awarded and paid; under dairy products $7.50 was awarded and paid; under domestic manufactures $83.60 was awarded and paid; under trotting $80 was paid; under objects other than agricultural, not specified, $42.75 was awarded and paid. The society reports 431 members, — 300 males and 131 females. Three farmers' institutes were held: at Chester, August 25, on "Rural and farm law;" at Middlefield, September 9, on general topics; and at Middlefield, October 26, on "Obstacles to successful farming, and how to overcome them."

HILLSIDE AGRICULTURAL SOCIETY.

Incorporated 1883, Acts of 1883, chapter 112.

Originally raised by contribution, $3,113.32; now has $5,955.60 invested as a capital stock in real estate, bank funds, crockery, tables, etc. Total assets, $5,955.60: real estate, $4,760.61; bank funds, $844.99; crockery, tables, etc., $350. Receipts in 1896, $1,754.96: bounty, $600; bank funds, $25.78; new members, $96; donations, $54.80; other sources, $978.38. Expenditures in 1896, $1,608.12: premiums paid, $782.80; current running expenses, $612.33;

* Of this amount, $80 was paid for trotting.

other expenses, $212.99. The society offered $785.50 in premiums, and awarded and paid $782.80, which went to 28 cities and towns. Four hundred and fourteen persons received premiums. Under head of farms $2 was awarded and paid; under farm and pet stock $472.50 was awarded and paid; under field and garden crops $51.50 was awarded and paid; under farm and garden products $82.30 was awarded and paid; under dairy products $17 was awarded and paid; under domestic manufactures $69.95 was awarded and paid; under trotting $25 was paid; under objects other than agricultural, not specified, $50 was awarded and paid. The society reports 726 members, — 699 males and 27 females. Four farmers' institutes were held: at Ashfield, February 15, on "Diseases and care of horses" and "Japan; its farms and farmers;" at Cummington, March 10, on "Taxation" and The work of the Board of Agriculture;" at Cummington, August 19, on "The political situation" and Co-operation among farmers;" and at Cummington, September 29, on "Obstacles to successful farming, and how to overcome them."

HINGHAM AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 99.

Originally raised by contribution, $17,406.15; now has $22,000 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $22,064.04: real estate, $20,000; crockery, tables, etc., $2,000; cash, $64.04. Receipts in 1896, $3,163.35: bounty, $600; new members, $5; donations, $132.15; other sources, $2,426.20. Expenditures in 1896, $3,265.13: premiums and gratuities paid, $634.50; current running expenses, $974.80; interest, $9.70; other expenses, $1,646.13. The society offered $2,048.80 in premiums, and awarded and paid $634.50 in premiums and gratuities, which went to 13 cities and towns. One hundred and fifty-four persons received premiums and 297 gratuities. Under head of farm and pet stock $268.65 was awarded and paid; under farm and garden products $228 was awarded and paid; under dairy products $5 was awarded and paid; under domestic manufactures $63.85 was awarded and paid; under objects other than agricultural, not specified, $69 was

awarded and paid. The society reports 735 members, — 515 males and 220 females. Eight farmers' institutes were held at Hingham: January 27, on "Among the ferns;" February 24, on "Cranberry culture," "Increasing of varieties of vegetables" and "The time to plant tomato seed, to pot plants, etc.;" March 23, on "Spraying trees and shrubs;" April 27, on "Observations at the Atlanta Exposition and in the South;" May 25, on "Fertilizers;" July 20, on "Market gardening;" August 17, on "What crops are most profitable to raise in Hingham?" and December 4, on "The best way to redeem a weedy, wornout lawn," "Cases of mildew in a grapery" and "Potato culture."

HOOSAC VALLEY AGRICULTURAL SOCIETY.

Incorporated 1860, Acts of 1860, chapter 56.

Originally raised by contribution, $2,006; now has $16,800 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $16,844.72: real estate, $16,300; crockery, tables, etc., $500; cash, $44.72. Total liabilities, $4,491 80: premiums due and unpaid, $991.80; outstanding bills, $200; note, $3,300. Receipts in 1896, $5,456.10: bounty, $600; new members, $45; other sources, $4,811.10. Expenditures in 1896, $5,978.04: premiums paid, $1,988.95; current running expenses, $3,116.59; interest, $82.50; other expenses, $790. The society offered $4,288 in premiums, awarded $2,980.75* and paid $1,988.95, which went to 21 cities and towns. One hundred and fifty-two dollars and twenty-five cents went to 3 towns outside the State. Two hundred and fifty-seven persons received premiums. Under head of farms $18 was awarded and paid; under farm and pet stock $623 was awarded and paid; under field and garden crops $165 was awarded and paid; under farm and garden products $161.50 was awarded and paid; under dairy products $21.50 was awarded and paid; under domestic manufactures $268.75 was awarded and paid; under agricultural implements $23 was awarded and paid; under trotting $1,570 was paid; under objects other than agricultural, not specified, $130 was awarded and paid. The society reports 977 members, — 961 males and 16 females.

* Of this amount, $1,570 was paid for trotting.

Three farmers' institutes were held: at Cheshire, February 20, on "Tuberculosis;" at Savoy, November 24, on "Economical feed for dairy cows;" and at Williamstown, December 31, on "The production of milk," "Management of a dairy farm," "Growing and feeding of forage crops for profit" and "Winter care of milch cows."

HOUSATONIC AGRICULTURAL SOCIETY.

Incorporated 1848, Acts of 1848, chapter 101.

The society in its first report to the Board in 1853 stated the amount of its permanent fund (par value) to be $6,335.33; now has $22,007.80 invested as a capital stock in real estate, stocks, and bank funds. Total assets, $22,661.61: real estate, $20,000; stocks, $1,000; bank funds, $1,007.80; crockery, tables, etc., $475; bills due and unpaid, $24; cash, $154.81. Total liabilities, $2,406.83: premiums due and unpaid and outstanding bills (estimated), $150; mortgages or like liabilities, $2,256.83. Receipts in 1896, $8,823.71: bounty, $600; stocks, $50; bank funds, $36.92; new members, $214; other sources, $7,922.79. Expenditures in 1896, $8,936.46: premiums and gratuities paid, including trotting, sports and attractions, $4,707.10; current running expenses, $3,069.10; interest, $109.80; other expenses, $1,050.46. The society offered $2,564.50 in premiums, awarded $2,155 and paid $2,114.50 in premiums and gratuities, which went to 17 cities and towns. Four hundred and eighty-three persons received premiums and gratuities. Under head of farm and pet stock $1,141.70 was awarded and $1,119.20 paid; under field and garden crops $227 was awarded and $224 paid; under farm and garden products $244.60 was awarded and $237.10 paid; under dairy products $42 was awarded and paid; under domestic manufactures $440 was awarded and $432.50 paid; under trotting $1,437.50 was paid; under objects other than agricultural, not specified, including sports, etc., $993 was paid. The society reports 1,708 members, — 1,657 males and 51 females. Three farmers' institutes were held: at Great Barrington, January 24, on "Pioneer work in tuberculosis;" at Lee, March 26, on "The Atlanta Exposition

and Farmers' National Congress: what I saw and heard there" and "What we know of stable manures;" and at Great Barrington, November 24, on "Book-farming *v.* moon-farming."

MANUFACTURERS' AGRICULTURAL SOCIETY OF NORTH ATTLEBOROUGH.

Incorporated 1896, Acts of 1896, chapter 260.

Originally raised by contribution, $10,000; now has $10,000 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $10,037.84: real estate, $9,500; crockery, tables, etc., $500; cash, $37.84. Total liabilities consist of outstanding bills to the amount of $9. Receipts in 1896, $3,857.27: bounty, $600; subscriptions, $302.25; other sources, $2,955.02. Expenditures in 1896, $3,857.27: premiums and gratuities paid, $634.65; current running expenses, $3,089.59; other expenses, $133.03. The society offered $1,190.55 in premiums, and awarded and paid $634.65 in premiums and gratuities, which went to 18 cities and towns. Forty-one dollars and ninety-five cents went to 5 cities and towns outside the State. Two hundred and two persons received premiums and 32 gratuities. Under head of farm and pet stock $321.05 was awarded and paid; under farm and garden products $157.45 was awarded and paid; under domestic manufactures $86.25 was awarded and paid; under objects strictly agricultural, not specified, $13.25 was awarded and paid; under trotting $1,350 was paid; under objects other than agricultural, not specified, $22.75 was awarded and paid. The society reports 46 male members. Three farmers' institutes were held at Attleborough; October 30, on "Fruit culture;" November 27, on "How to feed the dairy cow;" and December 22, on "Poultry for profit."

MARSHFIELD AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 116.

Originally raised by contribution, $3,755.43; now has $27,980.08 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $27,980.08: real estate,

$26,472.78; crockery, tables, etc., $1,507.30. Total liabilities, $5,800.45: premiums due and unpaid, $139.05; outstanding bills, $191.40; mortgages or like liabilities, $5,570. Receipts in 1896, $2,587.35: bounty, $600; new members, $35; donations, $134.95; other sources, $1,817.40. Expenditures in 1896, $2,330.36: premiums and gratuities paid, $877.60; current running expenses, $1,086.21; interest, $366.55. The society offered $1,229 in premiums, awarded $1,016.65 and paid $877.60,* which went to 28 cities and towns. Four dollars and fifty cents went to 3 cities and towns outside the State. Seventy-five persons received premiums and 250 gratuities. Under head of farm and pet stock $176.65 was awarded and $148.15 paid; under farm and garden products $110.10 was awarded and $73.60 paid; under dairy products $8 was awarded and $6 paid; under domestic manufactures $73.65 was awarded and $72.05 paid; under trotting $428 was paid; under objects other than agricultural, not specified, $25 was awarded and $23.05 paid. Diplomas were awarded for agricultural implements. The society reports 879 members, — 568 males and 311 females. Three farmers' institutes were held at Marshfield: January 18, on "How to keep up the fertility of the soil;" February 19, on "Fruits and poultry;" and June 17, on "Webster," "Patriotism" and "Cranberry culture."

MARTHA'S VINEYARD AGRICULTURAL SOCIETY.

Incorporated 1859, Acts of 1859, chapter 33.

Originally raised by contribution, $4,552.17; now has $4,329.13 invested as a capital stock in real estate, notes, bank funds, crockery, tables, etc. Total assets, $4,540.54: real estate, $2,750; notes, $500; bank funds, $879.13; crockery, tables, etc., $200; bills due and unpaid, $8; cash, $203.41. Liabilities, $24: premiums due and unpaid, $6; outstanding bills (estimated) $18. Receipts in 1896, $1,356.47: bounty, $600; notes, $31; bank funds, $32.47; new members, $4; other sources, $689. Expenditures in 1896, $1,074.59: premiums and gratuities paid, $643.20; current running expenses, $267.83; other expenses, $163.56. The society offered $813.50 in premiums, awarded $649.20

* Of this amount, $428 was paid for trotting.

and paid $643.20 * in premiums and gratuities, which went to 6 towns. Fifty-nine persons received premiums and 164 gratuities. Under head of farms $3 was awarded and paid; under farm and pet stock $237.30 was awarded and paid; under field and garden crops $21 was awarded and paid; under farm and garden products $83.80 was awarded and paid; under dairy products $11.25 was awarded and paid; under domestic manufactures $155.15 was awarded and paid; under objects strictly agricultural, not specified, $24.60 was awarded and paid; under trotting, $82.50 was paid; under objects other than agricultural, not specified, $30.61 was awarded and paid. The society reports 204 members, — 113 males and 91 females. Three farmers' institutes were held at West Tisbury: March 26, on "The creamery;" September 24, on "The farmer's home;" and December 29, on "Poultry raising."

MASSACHUSETTS HORTICULTURAL SOCIETY.

Incorporated 1829, Acts of 1829, chapter 22.

The first investment was from surplus, Jan. 16, 1835, and amounted to $525. The society now has $247,000 invested as a capital stock in real estate, library, bonds and furniture. Total assets, $335,379.17: real estate, $250,000; loan, $7,500; bonds, $26,852.50; bank funds, $1,651.36; library, furniture, etc., $42,890.60: bills due and unpaid, $1,535.46; cash, $4,949.25. Total liabilities, $10,050: premiums due and unpaid, $8,050; outstanding bills, $1,000; mortgages or like liabilities, $1,000. Receipts in 1896, $27,732.38: bounty, $600; notes, $304.85; bank funds, $29.59; bonds, $1,272.50; new members and assessments, $1,288; donations, $32; other sources, $24,205.44. Expenditures in 1896, $26,939.15: premiums and gratuities paid, $7,887.27; current running expenses, $16,971.88; other expenses, $2,-080. The society offered $8,250 † in premiums, awarded $7,950.27 † in premiums and gratuities and paid $7,887.27,† which went to 63 cities and towns. One hundred and sixty-three dollars went to 9 cities and towns outside the State. One hundred and ninety-two ‡ persons received premiums and 116 ‡ gratuities. Under head of farms $495 was awarded

* Of this amount, $82.50 was paid for trotting.

† Offered and awarded in 1895; paid in 1896. ‡ Not including school gardeners.

and $517 paid; under farm and garden products $7,248.75 was awarded and $7,442.52 paid. The society reports 766 members, — 713 males and 53 females. Eleven farmers' institutes were held at Horticultural Hall, Boston: January 4, the annual address of the president: January 11, on "Hardy garden plants;" January 18, on "Conservatism in scientific agriculture;" January 25, on "Stove plants in their native tropics;" February 8, on "Seeds and their adulterations;" February 15, on "Some scale insects;" February 29, on "Some tendencies and problems in the evolution of species among parasitical fungi;" March 14, on "Ornamental planting for parks and public grounds;" March 21, on "Grasses;" March 28, on "Manuring orchards;" and April 11, on "Mushrooms."

MASSACHUSETTS SOCIETY FOR PROMOTING AGRICULTURE.

Incorporated 1792, Acts of 1792, chapter 33.

This society made no returns to the Board of Agriculture for the year 1896.

MIDDLESEX NORTH AGRICULTURAL SOCIETY.

Incorporated 1855, Acts of 1855, chapter 315.

Originally raised by contribution, $3,000; now has $35,000 invested as a capital stock in real estate. Total assets, $37,574.96: real estate, $35,000; crockery, tables, etc., $370; bills due and unpaid, $20; cash, $2,184.96. Total liabilities, $9,775: premiums due and unpaid, $100; outstanding bills, $75; mortgages or like liabilities, $9,600. Receipts in 1896, $12,177.09: bounty, $600; new members, $19; donations, $54; other sources, $11,504.09. Expenditures in 1896, $3,760.97: premiums and gratuities paid, $798.25; current running expenses, $1,305.37; interest, $472.30; other expenses, $1,185.05. The society offered $1,487.25 in premiums, awarded $849.75 and paid $798.25 in premiums and gratuities, which went to 11 cities and towns. Under the head of farm and pet stock $360.75 was awarded; under farm and garden products $307.75 was awarded; under dairy products $5 was awarded; under

domestic manufactures $176.25 was awarded; under trotting $480 was paid. The society reports an estimated membership of 1,386, — 1,123 males and 263 females. Four farmers' institutes were held: at Westford, February 1, on "Tuberculosis and tuberculin;" at Acton, February 18, on "Fruit" and "The war against the gypsy moth;" at Pepperell, March 10, on "How to make good roads, with or without State aid" and "How to prevent tuberculosis and secure good milk and wholesome beef;" and at Littleton, April 11, on "Fruit culture."

MIDDLESEX SOUTH AGRICULTURAL SOCIETY.

Incorporated 1854, Acts of 1854, chapter 84.

Originally raised by contribution, $3,000; now has $13,000 invested as a capital stock in real estate. Total assets, $13,250: real estate, $13,000; crockery, tables, etc., $250. Total liabilities, $8,004.55: premiums due and unpaid, $54.55; outstanding bills, $200; mortgages or like liabilities, $7,750. Receipts in 1896, $4,633.88: bounty, $600; new members, $83.36; donations, $245.87; other sources, $3,704.65. Expenditures in 1896, $4,633.88: premiums and gratuities paid, $624.20; current running expenses, $2,665.54; interest, $294.14; other expenses, $1,050. The society offered $1,342.20 in premiums, awarded $678.75 in premiums and gratuities and paid $624.20, which went to 8 towns. Seventy-seven persons received premiums and 49 gratuities. Under head of farms $26 was awarded and $16 paid; under farm and pet stock $261.65 was awarded and $247.65 paid; under field and garden crops $53 was awarded and paid; under farm and garden products $121 was awarded and $97.70 paid; under dairy products $21 was awarded and $3 paid; under domestic manufactures $52.65 was awarded and $51.65 paid; under objects strictly agricultural, not specified, $125 was awarded and paid; under trotting $700 was paid; under objects other than agricultural, not specified, $18.45 was awarded and $12.20 paid. The society reports 574 members, — 374 males and 200 females. Three farmers' institutes were held: at Hudson,

February 20, on "Peach culture;" at Sherborn, February 21, on "Capital and labor on the farm;" and at South Framingham, December 19, on "Tree culture."

NANTUCKET AGRICULTURAL SOCIETY.

Incorporated 1856, Acts of 1856, chapter 25.

Originally raised by contribution $3,500; now has $3,200 invested as a capital stock in real estate. Total assets, $3,234.78: real estate, $3,200; cash, $34.78. Receipts in 1896, $1,379.67: bounty, $587.25; new members, $26; other sources, $766.62. Expenditures in 1896, $1,345.09: premiums and gratuities paid, $597.38; current running expenses, $747.71. The society offered $1,175.50 in premiums, awarded $658.64 in premiums and gratuities and paid $597.38,* which went to 1 town. One hundred and fifty-two persons received premiums and 90 gratuities. Under farms $17 was awarded and $15.30 paid; under farm and pet stock $328.75 was awarded and $295.88 paid; under field and garden crops $31.25 was awarded and $28.08 paid; under farm and garden products $89.25 was awarded and $80.33 paid; under dairy products $5.50 was awarded and $4.95 paid; under domestic manufactures $89.75 was awarded and $78.84 paid; under trotting $60 was paid; under objects other than agricultural, not specified, $37.40 was awarded and $34 paid. The society reports 548 members, — 217 males and 331 females. Three farmers' institutes were held at Nantucket: November 23, on general farm topics; December 29, on "Milch cows and dairy farming;" and December 30, on "Poultry raising."

OXFORD AGRICULTURAL SOCIETY.

Incorporated 1888, Acts of 1888, chapter 93.

Originally raised by contribution $4,400; now has $8,056.84 invested as a capital stock in real estate, cash, crockery, tables, etc. Total assets, $8,056.84: real estate, $7,500; crockery, tables, etc., $200; cash, $356.84. Total liabilities consist of mortgages or like liabilities to the amount of $300. Receipts in 1896, $1,987.49: bounty, $600; new

* Of this amount, $60 was paid for trotting.

members, $32; donations, $27.75; other sources, $1,987.49. Expenditures in 1896, $2,290.40: premiums paid, $1,283.83; current running expenses, $450; interest, $31.55; other expenses, $525.02. The society offered $1,800 in premiums, awarded $1,312.83 and paid $1,283.83,* which went to 17 cities and towns. Thirty-seven dollars went to 1 city outside the State. One hundred and twenty-one persons received premiums. Under head of farms $56.33 was awarded and $52.75 paid; under farm and pet stock $516.75 was awarded and $502.40 paid; under field and garden crops $42 was awarded and $40.87 paid; under farm and garden products $18 was awarded and $17.37 paid; under dairy products $6 was awarded and paid; under domestic manufactures $38.25 was awarded and $33.06 paid; under agricultural implements $1 was awarded and paid; under trotting $605 was paid; under objects other than agricultural, not specified, $29.50 was awarded and $25.38 paid. The society reports 636 members, — 342 males and 294 females. Three farmers' institutes were held: at Dudley, January 25, on "Stabling and care of milch cows" and "Country roads;" at Oxford, February 19, on "Does the capital invested in farm property pay?" and "The business side of fruit culture;" and at Oxford, March 11, on "Farm poultry."

PLYMOUTH COUNTY AGRICULTURAL SOCIETY.

Incorporated as the Agricultural Society in the County of Plymouth, 1819, Acts of 1819, chapter 2; name changed to Plymouth County Agricultural Society in 1870, Acts of 1870, chapter 251.

The society in its first report to the Board in 1853, stated the amount of its permanent fund (par value) to be $9,550; now has $35,700 invested as a capital stock in real estate, bank funds, crockery, tables, etc. Total assets, $35,858.76: real estate, $35,000; bank funds, $500; crockery, tables, etc., $200; cash, $158.76. Total liabilities, $5,812.94: outstanding bills, $62.94; notes, $5,750. Receipts in 1896, $5,914.38: bounty, $600; new members, $6; donations, $38.25; other sources, $5,274.13. Expenditures in 1896, $5,755.62: premiums and gratuities paid, $3,326.75; current running expenses, $2,157.42; interest, $271.45. The

* Of this amount, $605 was paid for trotting.

society offered $3,941.55 in premiums, awarded $3,346.75 in premiums and gratuities and paid $3,326.75,* which went to 39 cities and towns. Ninety-seven dollars and seventy cents went to 3 cities and towns outside the State. Three hundred and seventy persons received premiums and 30 gratuities. Under head of farms $51 was awarded and paid; under farm and pet stock $823 was awarded and paid; under field and garden crops $34 was awarded and paid; under farm and garden products $210 was awarded and paid; under dairy products $30 was awarded and paid; under domestic manufactures $202.70 was awarded and paid; under objects strictly agricultural, not specified, $45 was awarded and paid, under trotting $1,625 was paid; under objects other than agricultural, not specified, $32 was awarded and paid. The society reports 1,540 members, — 897 males and 643 females. Three farmers' institutes were held, at Middleborough, February 14, on "Concentrated feed stuffs and their relation to home-raised forage crops;" at West Bridgewater, April 3, on "Field crops;" and at Bridgewater, December 15, on "An egg farm."

SPENCER FARMERS' AND MECHANICS' ASSOCIATION.

Incorporated 1888, Acts of 1888, chapter 87.

Orginally raised by contribution, $4,034.08; now has $8,950 invested as a capital stock in real estate, bank funds, crockery, tables, etc. Total assets, $9,037.01: real estate, $7,000; bank funds, $1,000; crockery, tables, etc., $950; cash, $87.01. Receipts in 1896, $5,406.43: bounty, $600; new members, $11; donations, $2,000; other sources, $2,795.43. Expenditures in 1896, $4,319.42: premiums and gratuities paid, $1,679.41; current running expenses, $1,123.70; other expenses, $1,516.31. The society offered $2,500 in premiums, awarded $1,750 in premiums and gratuities and paid $1,679.41,† which went to 20 cities and towns. One hundred and twenty-two persons received premiums and 40 gratuities. Under head of farms $43 was awarded and paid; under farm and pet stock $659 was awarded and paid; under field and garden crops $38.25 was awarded and $34.75

* Of this amount, $1,625 was paid for trotting.

† Of this amount, $790 was paid for trotting.

paid; under farm and garden products $80.50 was awarded and $78.75 paid; under dairy products $10 was awarded and paid; under domestic manufactures $70.50 was awarded and $63.91 paid; under trotting $790 was paid. The society reports 953 members, — 526 males and 427 females. Three farmers' institutes were held at Spencer: January 29, on "The management of agricultural fairs;" January 30, on "General fruit culture;" and January 31, on "Grasses and forage crops."

UNION AGRICULTURAL AND HORTICULTURAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 110.

Originally raised by contribution $4,447.23; now has $9,000 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $9,627.01: real estate, $8,000; crockery, tables, etc., $1,000; cash, $627.01. Total liabilities, $2,211.04: premiums due and unpaid, $61.04; mortgages or like liabilities, $2,150. Receipts in 1896, $2,745.92: bounty, $600; new members, $54; donations, $5; other sources, $2,086.92. Expenditures in 1896, $2,118.91: premiums and gratuities paid (including $34.25 due for premiums awarded in 1895), $1,185.91; current running expenses, $755.58; interest, $122.13; other expenses, $55.29. The society offered $1,848.55 in premiums, awarded $1,212.70 in premiums and gratuities and paid $1,151.66, which went to 26 cities and towns. Eight dollars and seventy-five cents went to 3 towns outside the State. Two hundred and four persons received premiums and 82 gratuities. Under head of farm and pet stock $472.75 was awarded and $432.50 paid; under field and garden crops $49 was awarded and paid; under farm and garden products $47 was awarded and $39.88 paid; under dairy products $11.25 was awarded and paid; under domestic manufactures $107.41 was awarded and $94.36 paid; under agricultural implements $5.25 was awarded and $5.13 paid; under objects strictly agricultural, not specified, $105 was awarded and paid; under trotting $3.90 was paid; under objects other than agricultural, not specified, $25.04 was awarded and $24.54 paid. The society reports 1,281 mem-

bers, — 591 males and 690 females. Three farmers' institutes were held at Blandford; January 9, on "The Atlanta Exposition and Farmers' National Congress: what I saw and heard there;" February 3, on "Care and feed of cows for the creamery business, care of cream and the extra profit to the farmer;" and February 28, on "The dairy cow, feed, care and product."

WEYMOUTH AGRICULTURAL AND INDUSTRIAL SOCIETY.

Incorporated 1891, Acts of 1891, chapter 77.

Amount originally raised by contribution had increased in 1891 to $10,270; the society now has that amount invested as a capital stock in real estate, crockery, tables, etc. Total assets, $10,286.32: real estate, $10,000; crockery, tables, etc., $270; cash, $16.32: Total liabilities, $1,649.31: outstanding bills, $149.31; mortgages or like liabilities, $1,500. Receipts in 1896, $4,262.10: bounty, $600; bank funds, $1.70; donations, $35; other sources, $3,625.40. Expenditures in 1896, $3,715.44: premiums and gratuities paid, $754.55; current running expenses, $2,862.61; interest, $98.28. The society offered $984.55 in premiums, awarded $789.55 and paid $754.55, which went to 19 cities and towns. Five dollars went to parties not residents of the State. Three hundred and ten persons received premiums and gratuities. Under head of farm and pet stock $443.90 was awarded and $424.65 paid; under field and garden crops $7 was awarded and paid; under farm and garden products $162.85 was awarded and $149.35 paid; under dairy products $1.50 was awarded and paid; under domestic manufactures $135.80 was awarded and $133.55 paid; under trotting $1,137.50 was paid; under objects other than agricultural, not specified, $38.50 was awarded and paid. The society reports 430 members, — 418 males and 12 females. Four farmers' institutes were held at South Weymouth: April 14, on "Rural and farm law;" April 24, on "How to feed the dairy cow for milk and cream production;" May 22, on "Milk production;" and December 11, on "Value of frost warnings and use to make of them."

WORCESTER AGRICULTURAL SOCIETY.

Incorporated 1818, Acts of 1818, chapter 168.

The society in its first report to the Board in 1853 stated that the amount of its permanent fund (par value) was $7,730; now has $150,000 invested as a capital stock in real estate. Total assets, $150,973.76: real estate, $150,000; bank funds, $307.82; crockery, tables, etc., $600; bills due and unpaid, $65.94. Total liabilities, $55,084: premiums due and unpaid (pending investigation), $84; mortgages or like liabilities, $55,000. Receipts in 1896, $30,155.41: bounty, $600; bank funds, $53.19: new members, $355; donations, $1,920; other sources, $27,227.22. Expenditures in 1896, $29,847.59: premiums and gratuities paid, $10,054.25: current running expenses, $8,612.45; interest, $4,735.75; other expenses, $6,445.14. The society offered $12,413.25 in premiums, awarded $10,214.25 and paid $10,130.25,* which went to 85 cities and towns. Two thousand one hundred and seventeen dollars went to 26 cities and towns outside the State. Three hundred and seven persons received premiums and 2 gratuities. Under head of farm and pet stock $3,744.50 was awarded and $3,664.50 paid; under farm and garden products $883.50 was awarded and paid; under dairy products $158 was awarded and $154 paid; under domestic manufactures $138.75 was awarded and paid; under grange exhibits $70 was awarded and paid; under trotting $4,985 was paid; under objects other than agricultural, not specified, $234.50 was awarded and paid. The society reports 2,058 members, — 1,895 males and 163 females. Three farmers' institutes were held: at Grafton, February 18, on "The farm garden" and "Mending our ways;" at Worcester, February 20, on "Infectious diseases of domestic animals, their causation and prevention," and "The family vegetable garden;" and at Worcester, March 5, on "How to build a model barn" and "Ventilation."

* Of this amount, $4,985 was paid for trotting.

WORCESTER EAST AGRICULTURAL SOCIETY.

Incorporated 1890, Acts of 1890, chapter 41.

Originally raised by contribution, $1,015; now has $4,951.49 invested as a capital stock in real estate, cash, fixtures, crockery, tables, etc. Total assets, $4,951.49: real estate, $3,550; fixtures, $300; crockery, tables, etc., $200; cash, $901.49. Receipts in 1896, $4,693.97: bounty, $600; bank funds, $4.08; new members, $50; donations, $327.59; other sources, $3,712.30. Expenditures in 1896, $4,219.10: premiums paid, $1,153.05; current running expenses, $2,640.46; permanent improvements, $425.59. The society offered about $1,200 in premiums, awarded $1,174.05 and paid $1,153.05, which went to 20 cities and towns. Four dollars went to 1 city outside the State. Two hundred and twenty persons received premiums. Under head of farms $15 was awarded and paid; under farm and pet stock $601 was awarded and paid; under farm and garden products $188.25 was awarded and paid; under dairy products $80 was awarded and paid; under domestic manufactures $170.80 was awarded and paid; under agricultural implements $13 was awarded and paid; under objects strictly agricultural, not specified, $90 was awarded and paid; under trotting $262 was paid; under objects other than agricultural, not specified, $108 was awarded. The society reports 679 members, — 451 males and 228 females. Three farmers' institutes were held: at Clinton, January 30, on "Scoring by points on horses and cows;" at Lancaster, February 12; on "Flowers and plants" and "Peach culture;" and at Berlin, March 3, on "The Atlanta Exposition and Farmers' National Congress: what I saw and heard there" and "The quality of milk."

WORCESTER NORTH AGRICULTURAL SOCIETY.

Incorporated as the Fitchburg Agricultural Society, 1852, Acts of 1852, chapter 79; name changed to Worcester North Agricultural Society, 1853, Acts of 1853, chapter 359.

Originally raised by contribution, $2,128; now has $3,083.40 invested as a capital stock in real estate, cash, crockery, tables, etc. Total assets, $3,158.40: real estate, $2,500; crockery, tables, etc., $400; bills due and unpaid,

$75; cash, $183.40. Total liabilities, $1,227.39: premiums due and unpaid, $200; outstanding bills, $1,027.39. Receipts in 1896, $1,810.67: bounty, $561.21; bank funds, $20; new members, $107.26; other sources, $1,122.20. Expenditures in 1896, $1,633.32: premiums and gratuities paid, $659.40; current running expenses, $973.92. The society offered no fixed sum in premiums, but awarded and paid $659.40 in premiums and gratuities, which went to 10 cities and towns. One hundred and fifty persons received premiums and 26 gratuities. Under head of farms $16 was awarded and paid; under farm and pet stock $361.50 was awarded and paid; under farm and garden products $128 was awarded and paid; under dairy products $4 was awarded and paid; under domestic manufactures $44.65 was awarded and paid; under objects strictly agricultural, not specified, $60 was awarded and paid; under objects other than agricultural, not specified, $45.25 was awarded and paid. The society reports 799 members, — 738 males and 61 females. Five farmers' institutes were held: at Lunenburg, January 11, on "The farms and farmers of Japan;" at Westminster, January 29, on "Barn ventilation" and "Feeding and care of dairy stock;" at Ashburnham, February 15, on "Preparation of the soil for crops" and "The farmer as a citizen;" at Ashby, February 25, on "Potato culture" and "California through a farmer's eyes;" and at Fitchburg, March 19, on "The management of agricultural fairs" and "The farm, the grange and the home."

WORCESTER NORTH-WEST AGRICULTURAL AND MECHANICAL SOCIETY.

Incorporated 1867, Acts of 1867, chapter 117.

Originally raised by contribution $3,400; now has $12,213.26 invested as a capital stock in real estate, cash, crockery, tables, etc. Total assets, $12,213.26: real estate, $11,500; crockery, tables, etc., $600; cash, $113.26. Total liabilities consist of mortgages or like liabilities to the amount of $2,000. Receipts in 1896, $6,160.19: bounty, $600; new members, $117.50; other sources, $5,442.69. Expenditures in 1896, $7,450.81: premiums paid, $3,044.13; current running expenses, $3,406.76; interest, $120; other

expenses, $879.92. The society offered $3,761 in premiums, awarded $3,072.95 and paid $3,044.13,* which went to 41 cities and towns. Three hundred and seventy dollars went to 7 cities and towns outside the State. Two hundred and twenty-five persons received premiums. Under head of farms $30 was awarded and $29 paid; under farm and pet stock $810.50 was awarded and $804.17 paid; under farm and garden products $189.25 was awarded and $186.08 paid; under dairy products $20 was awarded and paid; under domestic manufactures $51.70 was awarded and $45.38 paid; under agricultural implements $8 was awarded and paid; under trotting $1,277.50 was paid; under head of objects other than agricultural, not specified, $686 was awarded and $674 paid. The society reports 1,002 members, — 647 males and 355 females. Four farmers' institutes were held: at Phillipston, January 15, on "Económical feed for dairy cows;" at Gardner, February 1, on "Manures and fertilizers and their use;" at Petersham, February 14, on "Stabling and care of milch cows" and "How to keep up the fertility of the soil;" and at Athol, March 18, on "Poultry keeping for the farm and farmers" and "The farm, the home and the grange."

WORCESTER SOUTH AGRICULTURAL SOCIETY.

Incorporated 1855, Acts of 1855, chapter 278.

Originally raised by contribution, $3,127.40; now has $8,500 invested as a capital stock in real estate, crockery, tables, etc. Total assets, 11,144.33: real estate, $10,300; crockery, tables, etc., $500; cash, $314.33. Total liabilities, $514.50: premiums due and unpaid, $14.50; mortgages or like liabilities, $500. Receipts in 1896, $4,340.30: bounty, $600; new members, $49; other sources, $3,691.30. Expenditures in 1896, $3,616 40: premiums and gratuities paid, $2,015.20; current running expenses, $1,445.42; interest, $45; other expenses, $110.78. The society offered $2,398 in premiums, awarded $2,029.70 in premiums and gratuities and paid $2,015.20,† which went to 26 cities and towns. One hundred and twenty-six persons received pre-

* Of this amount, $1,277.50 was paid for trotting.

† Of this amount, $790 was paid for trotting.

miums and 80 gratuities. Under head of farms $74 was awarded and paid; under head of farm and pet stock $878 was awarded and $871 paid; under farm and garden products $131.95 was awarded and paid; under dairy products $24 was awarded and paid; under domestic manufactures $93.50 was awarded and $93 paid; under agricultural implements $3 was awarded and paid; under objects strictly agricultural, not specified, $25 was awarded and paid; under trotting $790 was paid; under objects other than agricultural, not specified, $59.20 was awarded and paid. The society reports 1,744 members, — 880 males and 864 females. Three farmers' institutes were held: at Sturbridge, January 8, on "The products of the farmer's garden *v.* the contents of the pork barrel and the cook book" and "The management of agricultural fairs;" at Warren, January 29, on "How to prevent tuberculosis and secure pure milk and wholesome beef;" and at Southbridge, May 21, on "The farmer's economic need of bees."

WORCESTER COUNTY WEST AGRICULTURAL SOCIETY.

Incorporated 1851, Acts of 1851, chapter 278.

Originally raised by contribution, $3,175; now has $13,600 invested as a capital stock in real estate, crockery, tables, etc. Total assets, $13,608.87: real estate, $12,600; crockery, tables, etc., $1,000; cash, $8.87. Total liabilities consist of notes to the amount of $1,200. Receipts in 1896, $2,948.31: bounty, $600; new members, $57; donations, $39.14; other sources, $2,252.17. Expenditures in 1896, $3,050.58: premiums and gratuities paid, $1,494.70; current running expenses, $1,483.88; interest, $72. The society offered $1,823.25 in premiums and awarded and paid $1,494.70 * in premiums and gratuities, which went to 35 cities and towns. Twenty-five cents went to 1 city outside the State. One hundred and sixty persons received premiums and 44 gratuities. Under head of farms $34 was awarded and paid; under farm and pet stock $562.70 was awarded and paid; under field and garden crops $10 was awarded and paid; under farm and garden products $123.20

* Of this amount, $685 was paid for trotting.

was awarded and paid; under dairy products $12 was awarded and paid; under domestic manufactures $53.30 was awarded and paid; under trotting $685 was paid; under objects other than agricultural, not specified, $199.50 was awarded and paid. The society reports 518 members, — 463 males and 55 females. Four farmers' institutes were held: at Barre, February 7, on "Farming as a business;" at Hubbardston, February 14, on "Economical feed for dairy cows" and the "Production and sale of milk;" at North Brookfield, February 20, on "The cost of a quart of milk" and "An hour with the Babcock tester;" and at Oakham, March 7, on "Grasses and forage crops."

Summary.

	1894.	1895.	1896.
Number of societies,	*36	*35	†36
Amount held invested or well secured as a capital stock.	$776,486 22	$763,303 42	$801,791 3
Assets of societies,	868,860 56	861,719 36	902,393 40
Liabilities of societies,	142,119 01	139,821 46	156,161 90
Receipts,	186,244 37	188,403 88	204,241 16
Expenditures,	187,582 34	179,094 89	192,603 32
Bounty received from the State,	20,628 80	20,606 20	20,084 12
Current running expenses,	67,822 24	77,786 73	79,174 07
Amount of premiums offered,	81,096 42	85,838 53	87,491 75
Amount of premiums and gratuities awarded,	62,559 37	66,912 26	68,055 33
Amount of premiums and gratuities paid,	61,054 66	65,209 35	65,839 68
Amount awarded under head of farms,	1,477 50	1,391 00	1,127 33
Amount awarded under head of farm and pet stock.	22,024 70	22,158 47	21,167 61
Amount awarded under head of field and garden crops.	1,351 25	1,305 10	995 50
Amount awarded under head of farm and garden products.	13,369 47	13,483 29	13,107 22
Amount awarded under head of dairy products,	592 50	687 21	668 50
Amount awarded under head of domestic manufactures.	4,031 47	3,692 53	3,986 86
Amount awarded under head of miscellaneous,	3,031 59	3,138 52	4,722 50
Amount paid under head of trotting,	23,346 57	25,247 35	31,263 90
Number of persons receiving premiums,	7,921	7,247	7,666
Number of persons receiving gratuities,	1,908	2,872	1,842
Total male membership of the societies,	23,658	23,099	22,897
Total female membership of the societies,	7,050	7,017	7,503
Total membership of the societies,	30,708	30,116	30,400
Number of farmers' institutes held,	125	118	128

* One held no fair. † Two held no fair.

DIRECTORY

OF THE

Agricultural and Similar Organizations in the State.

FEBRUARY, 1897.

State Board of Agriculture, 1897.

Members ex Officio.

His Excellency ROGER WOLCOTT.
His Honor W. M. CRANE.
Hon. WM. M. OLIN, *Secretary of the Commonwealth.*
H. H. GOODELL, M.A., LL.D., *President Massachusetts Agricultural College.*
C. A. GOESSMANN, Ph.D., LL.D., *Chemist of the Board.*
WM. R. SESSIONS, *Secretary of the Board.*

Members appointed by the Governor and Council.

	Term expires
DWIGHT A. HORTON of Northampton,	1898
JAMES S. GRINNELL of Greenfield,	1899
SPRAGUE S. STETSON of Lakeville,	1900

Members chosen by the Incorporated Societies.

Amesbury and Salisbury (Agr'l and Hort'l),	F. W. SARGENT of Amesbury,	1900
Barnstable County,	JOHN BURSLEY of West Barnstable,	1898
Berkshire,	WESLEY B. BARTON of Dalton,	1900
Blackstone Valley,	CHAS. E. SEAGRAVE of Uxbridge,	1900
Bristol County,	N. W. SHAW of North Raynham,	1899
Deerfield Valley,	F. H. SMITH of Ashfield,	1899
Eastern Hampden,	O. P. ALLEN of Palmer,	1900
Essex,	F. H. APPLETON of Peabody (P. O. Lynnfield),	1899
Franklin County,	GEO. E. TAYLOR of Shelburne (P. O. Greenfield),	1898
Hampden,	—— ——	1900
Hampshire,	WM. P. BROOKS of Amherst,	1898
Hampshire, Franklin and Hampden,	EDWARD E. WOOD of Northampton,	1900
Highland,	SAMUEL M. RAYMOND of Hinsdale,	1899
Hillside,	C. K. BREWSTER of Worthington,	1899
Hingham (Agr'l and Hort'l),	EDMUND HERSEY of Hingham,	1900
Hoosac Valley,	N. B. BAKER of Savoy (P. O. Savoy Centre),	1900
Housatonic,	CHARLES B. BENEDICT of Egremont,	1900
Man'f'rs' Agr'l (N. Attleborough),	OSCAR S. THAYER of Attleborough,	1900
Marshfield (Agr'l and Hort'l),	WALTON HALL of Marshfield,	1900
Martha's Vineyard,	H. G. NORTON of West Tisbury,	1898
Massachusetts Horticultural,	E. W. WOOD of West Newton,	1900
Massachusetts Society for Promoting Agriculture,	FRANCIS SHAW of Wayland,	1900
Middlesex North,	A. C. VARNUM of Lowell,	1898
Middlesex South,	ISAAC DAMON of Wayland (P. O. Cochituate),	1899
Nantucket,	J. S. APPLETON, Jr., of Nantucket,	1900
Oxford,	W. M. WELLINGTON of Oxford,	1898
Plymouth County,	AUGUSTUS PRATT of North Middleborough,	1899
Spencer (Far's and Mech's Assoc'n),	JOHN G. AVERY of Spencer,	1898
Union (Agr'l and Hort'l),	CURTIS M. BLAIR of Blandford,	1898
Weymouth (Agr'l and Ind'l),	QUINCY L. REED of South Weymouth,	1900
Worcester,	J. LEWIS ELLSWORTH of Worcester,	1899
Worcester East,	W. A. KILBOURN of South Lancaster,	1900
Worcester North,	GEORGE CRUICKSHANKS of Fitchburg,	1899
Worcester North-west (Agr'l and Mech'l),	T. H. GOODSPEED of Athol (P. O. Athol Centre),	1898
Worcester South,	G. L. CLEMENCE of Southbridge,	1898
Worcester County West,	E. A. HARWOOD of North Brookfield,	1899

Organization of the Board.

OFFICERS.

President,	His Excellency ROGER WOLCOTT, *ex Officio.*
1st Vice-President,	JAMES S. GRINNELL of Greenfield.
2d Vice-President,	ELIJAH W. WOOD, West Newton.
Secretary,	WM. R. SESSIONS of Hampden.

Office, State House, Boston.

COMMITTEES.

Executive Committee.

Messrs. E. W. Wood of West Newton.
W. A. Kilbourn of South Lancaster.
Isaac Damon of Wayland.
D. A. Horton of Northampton.
A. C. Varnum of Lowell.
Wm. P. Brooks of Amherst.
Francis H. Appleton of Peabody.

Committee on Agricultural Societies.

Messrs. W. A. Kilbourn of South Lancaster.
Q. L. Reed of South Weymouth.
N. W. Shaw of North Raynham.
O. P. Allen of Palmer.
N. B. Baker of Savoy.

Committee on Domestic Animals and Sanitation.

Messrs. Isaac Damon of Wayland.
Geo. E. Taylor of Shelburne.
Francis Shaw of Wayland.
F. H. Smith of Ashfield.
Wesley B. Barton of Dalton.

Committee on Gypsy Moth, Insects and Birds.

Messrs. E. W. Wood of West Newton.
A. Pratt of North Middleborough.
F. W. Sargent of Amesbury.
S. S. Stetson of Lakeville.
John G. Avery of Spencer.

Committee on Dairy Bureau and Agricultural Products.

Messrs. D. A. Horton of Northampton.
Geo. L. Clemence of Southbridge.
J. L. Ellsworth of Worcester.
C. B. Benedict of Egremont.
E. E. Wood of Northampton.

Committee on Agricultural College and Education.

Messrs. A. C. Varnum of Lowell.
Geo. Cruickshanks of Fitchburg.
E. A. Harwood of North Brookfield.
John Bursley of West Barnstable.
C. K. Brewster of Worthington.

Committee on Experiments and Station Work.

Messrs. Wm. P. Brooks of Amherst.
Edmund Hersey of Hingham.
C. M. Blair of Blandford.
W. M. Wellington of Oxford.
Walton Hall of Marshfield.

Committee on Forestry, Roads and Roadside Improvements.

Messrs. Francis H. Appleton of Peabody.
S. M. Raymond of Hinsdale.
J. S. Appleton, Jr., of Nantucket.
H. G. Norton of West Tisbury.
C. E. Seagrave of Uxbridge.

The Secretary is a member, *ex officio*, of each of the above committees.

DAIRY BUREAU.

Messrs. D. A. Horton of Northampton, 1898, Geo. L. Clemence of Southbridge, 1899, J. Lewis Ellsworth of Worcester, 1897, *appointed by the Governor*. Secretary Wm. R. Sessions, *Executive Officer*. Geo. M. Whitaker of Boston, 1897, *Assistant Executive Officer, appointed by the Governor.*

SPECIALISTS.

By Election of the Board.

Chemist,	Dr. C. A. Goessmann,	Amherst.
Entomologist,	Prof. C. H. Fernald,	Amherst.
Botanist and Pomologist,	Prof. S. T. Maynard,	Amherst.
Veterinarian,	Prof. James B. Paige,	Amherst.
Engineer,	Wm. Wheeler,	Concord.
Ornithologist,	E. H. Forbush,	Malden.

By Appointment of the Secretary.

Librarian and Curator, F. H. Fowler, B.Sc., *First Clerk*.

Massachusetts Agricultural College.

Location, Amherst, Hampshire County.

Board of Trustees.	Term Expires
James S. Grinnell of Greenfield,	1898
Charles L. Flint of Brookline,	1898
William H. Bowker of Boston,	1899
J. D. W. French of North Andover,	1899
J. Howe Demond of Northampton,	1900
Elmer D. Howe of Marlborough,	1900
Nathaniel I. Bowditch of Framingham,	1901
William Wheeler of Concord,	1901
Elijah W. Wood of West Newton,	1902
Chas. A. Gleason of New Braintree,	1902
Samuel C. Damon of Lancaster,	1903
James Draper of Worcester,	1903
Henry S. Hyde of Springfield,	1904
Merritt I. Wheeler of Great Barrington,	1904

Members ex Officio.

His Excellency Governor Roger Wolcott,
President of the Corporation.

Henry H. Goodell, M.A., LL.D.,	*President of the College.*
Frank A. Hill,	*Secretary of the Board of Education.*
William R. Sessions,	*Secretary of the Board of Agriculture.*

Officers Elected by the Board of Trustees.

James S. Grinnell of Greenfield,	*Vice-President of the Corporation.*
William R. Sessions of Hampden,	*Secretary.*
Prof. Geo. F. Mills of Amherst,	*Treasurer.*
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Board of Overseers.

The State Board of Agriculture.

Examining Committee of the Board of Agriculture.

Messrs. Varnum, Cruickshanks, Harwood, Bursley and Brewster.

Hatch Experiment Station of the Massachusetts Agricultural College.

Henry H. Goodell, M.A., LL.D.,	*Director.*
William P. Brooks, B.Sc.,	*Agriculturist.*
Samuel T. Maynard, B.Sc.,	*Horticulturist.*
Charles H. Fernald, Ph.D.,	*Entomologist.*
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Joseph B. Lindsey, Ph.D.,	*Chemist* (Foods and Feeding).
George E. Stone, Ph.D.,	*Botanist.*
Leonard Metcalf, B.S.,	*Meteorologist.*

Board of Cattle Commissioners.	Term Expires
Austin Peters, M.R.C.V.S., of Boston, *Chairman*,	1897
John M. Parker, V.S., of Haverhill, *Secretary*,	1899
L. F. Herrick of Millbury,	1897
Charles A. Dennen of Pepperell,	1897
Maurice O'Connell, D.V.S., of Holyoke,	1898

Office, Commonwealth Building, Boston.

AGRICULTURAL SOCIETIES INCORPORATED BY SPECIAL ACT OF LEGISLATURE, AND REPRESENTED ON THE BOARD OF AGRICULTURE.

NAME.	PRESIDENT.	SECRETARY.	TREASURER.
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Blackstone Valley,	Samuel B. Taft, Uxbridge.	Augustus Story, Uxbridge.	Edwin C. Tuttle, Uxbridge.
Bristol County,	W. C. Baylies, Taunton.	Gertrude Williams, Taunton.	E. C. Holt, Taunton.
Deerfield Valley,	C. H. Leavitt, East Charlemont.	S. W. Hawkes, Charlemont.	E. F. Haskins, Charlemont.
Eastern Hampden,	A. D. Norcross, Monson.	F. D. Barton, Palmer.	F. D. Barton, Palmer.
Essex,	O. S. Butler, Georgetown.	J. M. Danforth, Lynnfield Centre.	G. L. Streeter, Salem.
Franklin County,	A. A. Smith, Colrain.	F. N. Thompson, Greenfield.	F. N. Thompson, Greenfield.
Hampden,	- -	W. F. Gale, Springfield.	E. S. Batchelder, Springfield.
Hampshire,	Geo. P. Smith, Sunderland.	Herbert Sabin, Amherst.	Herbert Sabin, Amherst.
Hampshire, Franklin and Hampden,	H. C. Comins, Hadley.	S. S. Warner, Northampton.	D. J. Wright, Northampton.
Highland,	Jonathan McElwain, Middlefield.	John T. Bryan, Middlefield.	M. J. Smith, Middlefield.
Hillside,	S. W. Clark, Plainfield.	W. G. Atkins, West Cummington.	R. R. Packard, Cummington.
Hingham,*	E. L. Ripley, Hingham.	William H. Thomas, Hingham.	Reuben Sprague, Hingham.
Hoosac Valley,	W. B. Plunkett, Adams.	George F. Miller, North Adams.	E. M. Meekins, North Adams.
Housatonic,	C. B. Benedict, Egremont.	Frank H. Briggs, Great Barrington.	O. C. Bidwell, Great Barrington.
Manufacturers' Agricultural,	W. H. Riley, North Attleborough.	Wm. H. Pond, Attleborough.	W. W. Sherman, North Attleborough.
Marshfield,*	Walton Hall, Marshfield.	Francis Collamore, North Pembroke.	Francis Collamore, North Pembroke.
Martha's Vineyard,	H. G. Norton, West Tisbury.	B. T. Hillman, Edgartown.	Geo. H. Luce, West Tisbury.
Massachusetts Horticultural,	Francis H. Appleton, Peabody.	Robert Manning, Boston.	C. E. Richardson, Cambridgeport.
Massachusetts Society for Promoting Agriculture,	Chas. S. Sargent, Brookline.	Francis H. Appleton, Peabody.	J. C. Rogers, Boston.
Middlesex North,	A. C. Varnum, Lowell.	E. T. Rowell, Lowell.	S. Drewett, Lowell.
Middlesex South,	Geo. L. Whitney, Sherborn.	Geo. C. Blades, South Framingham.	Edgar Potter, South Framingham.
Nantucket,	Thomas G. Macy, Nantucket.	J. F. Murphy, Nantucket.	Asa C. Jones, Nantucket.
Oxford,	J. W. Stockwell, Sutton.	W. H. H. Thurston, Oxford.	W. H. H. Thurston, Oxford.
Plymouth County,	I. N. Nutter, East Bridgewater.	Geo. M. Hooper, Bridgewater.	H. D. Packard, Bridgewater.
Spencer (Farmers' and Mechanics' Association),	T. J. Comins, Spencer.	F. B. Watson, Spencer.	A. W. Curtis, Spencer.

Union,*	Geo. Emmons, Blandford.	E. W. Boise, Blandford.	A. H. Nye, Blandford.
Weymouth (Ag'l and Ind.),	B. F. Poole, Rockland.	H. Wilbur Dyer, South Weymouth.	F. L. Bayley, South Weymouth.
Worcester,	W. C. Jewett, Worcester.	John B. Bowker, Worcester.	John B. Bowker, Worcester.
Worcester East,	John E. Thayer, Lancaster.	W. A. Kilbourn, South Lancaster.	Lucius Field, Clinton.
Worcester North,	J. L. Harrington, Lunenburg.	John H. White, Fitchburg.	Geo. O. Allen, Fitchburg.
Worcester North-west (Ag'l and Mechanical),	B. W. Spooner, Petersham.	J. H. Humphrey, Athol Center.	T. H. Goodspeed, Athol Center.
Worcester South,	A. B. Chamberlain, Sturbridge.	C. V. Corey, Sturbridge.	C. V. Corey, Sturbridge.
Worcester County West,	George Mixter, Hardwick.	Matthew Walker, Barre.	Charles H. Follansby, Barre.

* And horticultural.

HORTICULTURAL SOCIETIES.

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Cape Ann,	Gloucester,	Geo. F. Thayer, Gloucester.	Geo. E. Merchant, Gloucester.
Haverhill,	Haverhill,	Walter Goodrich, Haverhill.	Mrs. William M. Webster, Bradford.
Hampden County,	Springfield,	Edward P. Chapin, Springfield.	W. F. Gale, Springfield.
Houghton,	Lynn,	Walter B. Allen, Lynn.	Miss Ruth S. Wood, Lynn.
Hyde Park,	Hyde Park,	Hugh J. Stockford, Hyde Park.	J. R. Andrews, Hyde Park.
Lenox,	Lenox,	Alexander MacConache, Lenox.	Edwin Jenkins, Lenox.
Massachusetts,	Boston,	Francis H. Appleton, Peabody.	Robert Manning, Boston.
Newton,	Newton,	D. D. Slade, Chestnut Hill.	L. H. Farlow, Newton.
Springfield Amateur,	Springfield,	W. T. Hutchins, Indian Orchard.	Chas. L. Burr, Springfield.
Wakefield,	Wakefield,	W. S. Ripley, Wakefield.	Chas. Talbot, Wakefield.
Worcester County,	Worcester,	O. B. Hadwen, Worcester.	Adin A. Hixon, Worcester.

FARMERS' AND MECHANICS' ASSOCIATIONS.

Bolton,	Bolton,	H. F. Haynes, Bolton.	Wm. M. Brigham, Bolton.
Leominster,	Leominster,	A. L. Whitney, Leominster.	C. C. Foster, Leominster.
Middlesex and Worcester,	Hudson,	A. F. Hall, Hudson.	Josiah S. Welsh, Hudson.

Farmers' and Mechanics' Associations — *Concluded.*

NAME.	LOCATION.	PRESIDENT.	SECRETARY.
Needham,	Needham,	Dr. Albert E. Miller, Needham.	Cyrus W. Jones, Needham.
Oakham,	Oakham,	H. P. Austin, Oakham.	Wm. S. Crawford, Oakham.
Princeton,	Princeton,	J. C. F. Mirick, Princeton.	J. E. Merriam, Princeton.
Westminster,	Westminster,	E. C. Damon, Westminster.	Judson Foster, South Westminster.
Farmers' and Mechanics' Clubs.			
Ashburnham,	Ashburnham,	Chas. H. Gates, Ashburnham.	Chas. F. Packard, Ashburnham.
Ashby,	Ashby,	H. S. Brooks, Ashby.	C. S. Blake, Ashby.
Belchertown,	Belchertown,	D. F. Shumway, Belchertown.	Geo. H. B. Green, Belchertown.
Berlin,	Berlin,	P. B. Southwick, Clinton.	J. D. Southwick, Berlin Centre.
Groton,	Groton,	T. Lawrence Motley, Groton.	Charles Woolley, Groton.
Holden,	Holden,	H. W. Warren, Holden.	Geo. S. Graham, Holden.
Pepperell,	Pepperell,	A. N. Blood, Pepperell.	S. R. Merrill, Pepperell.
Shirley,	Shirley,	H. S. Hazen, Shirleyville.	John W. Thacher, Shirleyville.
Shrewsbury,	Shrewsbury,	E. A. Bartlett, Shrewsbury.	F. J. Stone, Shrewsbury.
West Acton,	West Acton,	Isaac Reed, West Acton.	Chas. B. Stone, West Acton.
Wilmington,	Wilmington,	H. Allen Sheldon, Wilmington.	Ed. M. Nichols, Wilmington.
Farmers' Clubs.			
Ashfield,	Ashfield,	John M. Sears, Ashfield.	A. G. Howes, Ashfield.
Boxborough,	Boxborough,	Edward Wetherbee, Boxborough.	J. F. Hayward, West Littleton.
Buckland,	Buckland,	Chas. E. Ward, Buckland.	Eli C. Maynard, Buckland.
Chamberlain District,	Worcester,	Wm. I. Allen, Worcester.	S. A. Burgess, Worcester.
East Charlemont,	East Charlemont,	Horace Manning, East Charlemont.	E. P. Dickinson, East Charlemont.
Easthampton,	Easthampton,	E. H. Clark, Easthampton.	C. W. Smith, Easthampton.
Franklin,	Franklin,	C. M. Allen, Franklin.	L. W. Daniels, Franklin.
Halifax,	Halifax,	Otis Pratt, Halifax.	Mrs. J. S. Pope, Halifax.

Huntington,	Huntington,	C. H. Strong, Norwich.	H. W. Stickney, Norwich.
Lancaster,	Lancaster,	G. F. Morse, South Lancaster.	F. A. Hanaford, South Lancaster.
New Braintree,	New Braintree,	Edwin L. Havens, New Braintree.	Emma A. Moore, New Braintree.
New Salem,	New Salem,	D. F. Carpenter, Millington.	Willard Putnam, Cooleyville.
Practical,	Egremont,	L. T. Osborne, Alford.	Mrs. W. C. Dalzell, South Egremont.
Rehoboth,	Rehoboth,	F. A. Bliss, Pawtucket, R. I.	A. A. Bliss, Pawtucket, R. I.
Rowley,	Rowley,	J. D. Dodge, Rowley.	T. P. Hale, Rowley.
Royalston,	Royalston,	- - -	G. E. Pierce, Royalston.
Rutland,	Rutland,	L. S. Dudley, West Rutland.	Mrs. W. G. Wales, Rutland.
South Bristol,	New Bedford,	Franklyn Howland, Acushnet.	A. P. R. Gilmore, Long Plain.
Sterling,	Sterling,	A. H. Melendy, Sterling.	Ezra Sawyer, Sterling.
Tatnuck,	Worcester,	Elliott Moore, Worcester.	Isaac Wright, Tatnuck.
Upton,	Upton,	Chas. A. Whitney, Upton.	Perley W. Rockwood, Upton.
Waltham,	Waltham,	M. R. Leonard, Waltham.	A. Starbuck, Waltham.
West Bridgewater,	West Bridgewater,	F. E. Howard, West Bridgewater.	Anna S. LeLacheur, Bridgewater.
West Brookfield,	West Brookfield,	W. E. Patrick, Warren.	L. H. Chamberlain, West Brookfield.
West Newbury,	West Newbury,	Ezekiel G. Nason, West Newbury.	A. L. Moore, West Newbury.
West Peabody,	West Peabody,	Mrs. F. C. Durkee, West Peabody.	Bertha G. Small, West Peabody.
Wilbraham,	Wilbraham,	B. F. Green, North Wilbraham.	H. M. Bliss, Wilbraham.

MISCELLANEOUS.

Agricultural Library Association,	Swansea,	Samuel G. Arnold, Swansea Village.	A. E. Arnold, Swansea Centre.
Boston Market Gardeners' Association,	Boston and vicinity,	W. W. Rawson, Arlington.	C. A. Learned, Arlington.
Bristol Co. Fruit Growers' Association,	Dighton,	N. W. Shaw, North Raynham.	Wm. P. Eddy, Dighton.
Bay State Agricultural Society,	Boston,	J. D. W. French, Boston.	C. M. Weld, Brookline.
Brockton Agricultural Society,	Brockton,	Henry W. Robinson, Auburndale.	Ira Copeland, Brockton.
Burlington Agricultural Society,	Burlington,	- - -	H. H. Nichols, Burlington.
Cranberry Growers' Association,	Cape Cod District,	A. D. Makepeace, West Barnstable.	Franklin Crocker, Hyannis.
Farmers' and Gardeners' Club,	Hanson,	George F. Simpson, Hanson.	F. S. Thomas, M.D., Hanson.
Franklin Harvest Club,	Connecticut Valley,	R. W. Bemis, Chicopee.	C. B. Lyman, Southampton.
Hampden Harvest Club,	Connecticut Valley,	The members alternately.	J. N. Bagg, West Springfield.
Massachusetts Fruit Growers' Association,	The State,	George Cruickshanks, Fitchburg.	S. T. Maynard, Amherst.
Westborough Agricultural Society,	Westborough,	John B. Fitch, Westborough.	George M. Howe, Westborough.
Young Men's Harvest Club,	Ludlow,	H. E. Miller, Ludlow.	E. N. Fisher, Ludlow.
Young People's Agricultural Club,	Wilbraham,	Geo. A. Chapin, Hampden.	Walter M. Bliss, Wilbraham.

Massachusetts Patrons of Husbandry.

Officers of the State Grange, 1897.

Master,	E. D. Howe of Marlborough.
Overseer,	E. A. Emerson of Haverhill.
Lecturer,	J. W. Stockwell of Sutton.
Steward,	Walter B. Mellen of Brookfield.
Assistant Steward,	Wm. N. Howard of South Easton.
Chaplain,	Rev. C. S. Walker of Amherst.
Treasurer,	F. A. Harrington of Worcester.
Secretary,	W. C. Jewett of Worcester.
Gate Keeper,	Chas. M. Wood of Upton.
Pomona,	Mrs. Elbridge Cushman of Lakeville.
Flora,	Mrs. Lizzie H. Sargent of Merrimac.
Ceres,	Mrs. Geo. S. Ladd of Sturbridge.
Lady Assistant Steward,	Mrs. S. Ella Southland of Athol.

Executive Committee.

C. A. Dennen,	Pepperell.
Geo. L. Clemence,	Southbridge.
H. A Barton,	Dalton.

Deputies.

Geo. S. Ladd,	Sturbridge.
J. F. Whitcomb,	Athol.
Marcellus Boynton,	Central Village.
Wm. N. Howard,	South Easton.
T. E. Flarity,	Townsend.
Herbert Sabin,	Amherst.
F. H. Stevens,	West Acton.
C. D. Richardson,	West Brookfield.
Chas. G. Hinckley,	Lee.
F. G. Bennett,	Ludlow.
Alonzo Eaton,	Fitchburg.
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Edward A. Fuller,	North Andover.

Special Deputy.

W. B. Barton,	Dalton.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

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Middlesex and Worcester, No. 3,	Orlando E. Patch, Concord.	Emma F. Gates, Townsend.	Mrs. Annie E. Robbins, Lowell.
Franklin and Worcester, No. 4,	M. D. Herrick, North Orange.	E. S. Young, Orange.	C. Waldo Bates, Athol.
Worcester West, No. 5, . .	J. Frank Flagg, Hubbardston.	Lyman Randall, Petersham.	Chas. W. Snow, Nichewaug.
Berkshire County, No. 6, . .	J. S. Cole, Hinsdale.	Chas. Shaylor, Lee.	M. Agnes Young, Dalton.
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Hampshire County, No. 8, .	I. M. Day, South Hadley.	W. H. Gaylord, South Hadley.	Miss Sarah E. Mason, Northampton.
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Springfield, No. 12, ...	C. C. Keep, Monson.	Mrs. C. H. Burleigh, Hampden.	Mrs. C. Leonard Heyward, Agawam.
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Worcester East, No. 14, . .	Calvin H. Hastings, Clinton.	Mrs. M. H. Mentzer, Bolton.	Mrs. E. T. Cunningham, Lancaster.
Quabaug, No. 15, ...	A. C. Stoddard, North Brookfield.	Elisha Webb, West Brookfield.	Mrs. J. Georgia Stoddard, N. Brookfield.
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Groton, No. 7, ...	Myron P. Swallow, Groton.	Lizzie E. Starr, Groton.	Eva A. Clark, Groton.
Barre, No. 9, ...	J. F. Rice, Barre.	Mrs. Geo. Johnson, Barre.	E. W. Nourse, Barre.
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Hinsdale, No. 19, ...	C. C. Robinson, Jr., Hinsdale.	C. C. Robinson, Hinsdale.	John S. Cole, Hinsdale.
Westfield, No. 20, ...	Geo. W. Rosabock, Westfield.	Fred A. Pitcher, Westfield.	Miss Frances Abbott, Westfield.
Worcester, No. 22, ...	F. H. Chamberlain, Worcester.	J. B. Bowker, Worcester.	Ellen M. Flagg, Worcester.
Dalton, No. 23, ...	J. W. Fuller, Dalton.	Mrs. W. H. Woodworth, Dalton.	M. Agnes Young, Dalton.
Easthampton, No. 27, . .	Geo. Emerson Searles, Easthampton.	Mrs. O. Harrington, Easthampton.	Wm. C. Clapp, Easthampton.
Middlefield, No. 33, ...	M. J. Smith, Middlefield.	Henry S. Pease, Middlefield.	Edwin H. Alderman, Middlefield.
Sterling, No. 53, ...	F. E. Willard, Sterling.	Jos. R. Graham, Sterling.	Louis A. Stuart, Sterling.
Auburn, No. 60, ...	Joseph A. Allen, Auburn.	M. L. Hervey, Auburn.	J. H. Prouty, Auburn.
"Union" of Belchertown, No. 64, ...	R. W. Lyman, Northampton.	M. A. Morse, Belchertown.	Mrs. M. G. Ward, Belchertown.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Continued.*

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Hardwick, No. 67,	Geo. S. Prouty, Furnace.	Mrs. Nellie Paige, Hardwick.	W. A. Newcomb, Hardwick.
Phillipston, No. 70,	Lucien Gove, East Templeton.	G. R. Johnson, Templeton.	J. W. Moore, Templeton.
"Prescott" of Pepperell, No. 73,	Geo. H. Stewart, Pepperell.	A. N. Blood, Pepperell.	P. J. Kemp, Pepperell.
Holden, No. 78,	Levi H. Howe, Holden.	Mrs. G. S. Graham, Holden.	Mrs. S. N. Hubbard, Holden.
Spencer, No. 79,	A. W. Hoyle, Spencer.	P. Emerson, Spencer.	Clarence W. Grosvenor, Leicester.
"Manhan" of Southampton, No. 82,	J. S. Frary, Southampton.	Mrs. J. S. Frary, Southampton.	Mrs. Geo. K. Edwards, Southampton.
North Orange, No. 86,	M. L. Gerhard, Tully.	M. D. Herrick, North Orange.	Martha A. Cheney, North Orange.
Lee, No. 88,	James E. Seacord, Lenox.	Mrs. W. A. Dikeman, Lee.	Mrs. C. O. Swift, Lee.
Charlton, No. 92,	C. W. Pike, Charlton Depot.	E. M. Bowers, Charlton Depot.	A. R. Bigelow, Charlton Centre.
Grafton, No. 93,	Henry R. Leland, Grafton.	Fred E. Goddard, Farnumsville.	Edward S. Clark, Jr., Grafton.
Petersham, No. 95,	Chas. W. Snow, Nichewaug.	Mrs. R. J. Stone, Petersham.	Mrs. L. Willey, Petersham.
Shrewsbury, No. 101,	Thos. F. Marston, Shrewsbury.	Mrs. Geo. E. Brigham, Shrewsbury.	Anne S. Rice, Shrewsbury.
Stow, No. 103,	G. W. Bradley, Stow.	Elsie G. Whitcomb, Stow.	Mrs. U. M. Lewis, Stow.
"Garfield," of North Dana, No. 104,	M. T. Knapp, North Dana.	Willard Childs, North Dana.	Mrs. E. E. Hanson, North Dana.
Marlborough, No. 105,	E. N. Stratton, Marlborough.	Mrs. W. A. Porter, Marlborough.	Mrs. E. N. Stratton, Marlborough.
West Boylston, No. 106,	Harry A. Harlow, West Boylston.	Mrs. Geo. A. Barker, West Boylston.	Mabel E. Fisher, West Boylston.
Millbury, No. 107,	Herbert McCracken, West Millbury.	Mabel R. Searles, Millbury.	Chas. H. Stockwell, West Millbury,
Hudson, No. 108,	F. W. Ordway, Hudson.	L. W. Bruce, Hudson.	Mary E. Hall, Hudson.
Sutton, No. 109,	John Gifford, Sutton.	Dr. E. A. Welch, Sutton.	Sarah M. Mills, Sutton.
Sherborn, No. 110,	D. L. Whitney, South Framingham.	N. B. Douglas, Sherborn.	Miss A. L. Buckford, Sherborn.
Boylston, No. 111,	Chas. C. Bray, Boylston Centre.	Mrs. J. G. Warner, Boylston Centre.	Wm. H. Warner, Boylston Centre.
"East Medway" of Millis, No. 112,	J. Clarence Thorne, Millis.	Dr. H. P. Hooper, Millis.	Herbert Thorne, Millis.
Framingham, No. 113,	C. F. Hunt, Fayville.	Mrs. E. S. Trask, Framingham.	Mrs. Florence M. Perry, Framingham.
Medfield, No. 114,	Mrs. S. Minnie Chase, Medfield,	Miss Alice McLaughlin, Medfield.	Mrs. W. W. Preston, Medfield.
Holliston, No. 115,	S. G. Herrick, Holliston.	Mrs. G. F. French, Holliston.	Frances J. Hayes, Holliston.
Westborough, No. 116,	E. B. Emery, Westborough.	Mrs. Mary C. Graham, Westborough.	Mrs. E. C. B. Leonard, Westborough.
Dover, No. 117,	James McGill, South Natick.	Sarah Higgins, Dover.	Fannie C. Paine, Dover.
Southborough, No. 118,	Irving S. Hosmer, Southborough.	Fred A. Card, Southborough.	Mrs. Irving S. Hosmer, Southborough.
Northborough, No. 119,	J. K. Mills, Northborough.	Mrs. Mary S. Wood, Northborough.	Edith J. Bemis, Northborough.
Lancaster, No. 120,	Miss Ella C. Divoll, Lancaster.	Mrs. R. M. Farnsworth, Lancaster.	Mrs. E. A. Currier, Clinton.

Sudbury, No. 121,	E. W. Goodnow, South Sudbury.	H. N. Smith, South Sudbury.	Fred A. Noyes, Sudbury.
Templeton, No. 122,	J. A. Braithwaite, Templeton.	Mrs. E. C. Hersey, Templeton.	Chas. H. Lane, Templeton.
Oxford, No. 123,	Franklin H. Clark, Oxford.	Miss G. I. Bardwell, Oxford.	Geo. S. Eddy, Oxford.
Ashland, No. 124,	David A. Burgess, Ashland.	Chas. Adams, Ashland.	Fannie A. Pratt, Ashland.
Upton, No. 125,	Albert Davis, Upton.	M. S. King, Upton.	L. Jennie Chapman, West Upton.
Hubbardston, No. 126,	Chas. C. Colby, Hubbardston.	Mrs. Alice Colby, Hubbardston.	Mrs. Annie M. Leach, Hubbardston.
Amesbury, No. 127,	Gideon W. Evans, Amesbury.	John P. Titcomb, Amesbury.	Miss Nellie Huntington, Amesbury.
North Andover, No. 128,	Geo. A. Rogers, North Andover Depot.	Peter Holt, Jr., North Andover.	Samuel D. Berry, North Andover.
Gardner, No. 130,	Herbert F. Smith, South Gardner.	Mrs. Minnie E. Barney, Gardner.	Mrs. Ada Hobby, Gardner.
Boxborough, No. 131,	R. Y. Nelson, West Acton.	Mrs. S. B. Hager, West Acton.	Mrs. A. Littlefield, West Acton.
North Brookfield, No. 132,	Arthur C. Bliss, North Brookfield.	A. C. Stoddard, North Brookfield.	Geo. P. Buck, North Brookfield.
West Dedham, No. 133,	W. W. Baker, West Dedham.	Addie L. Gay, West Dedham.	Irene Roby, West Dedham.
Berlin, No. 134,	Henry A. Wheeler, Berlin.	Mrs. Jennie Keyes, Berlin.	Mrs. H. B. Allen, South Berlin.
Norfolk, No. 135,	Geo. E. Holbrook, Norfolk.	Silas E. Fales, Norfolk.	Sarah B. Sims, Norfolk.
Ipswich, No. 136,	W. Quincy Kinsman, Ipswich.	Elizabeth Kinsman, Ipswich.	J. Albert Smith, Ipswich.
East Blackstone, No. 137,	Sylvanus H. White, Blackstone.	Nannie I. White, Blackstone.	Arthur S. White, Blackstone.
Northampton, No. 138,	Edward P. West, Hadley.	Albert L. Phelps, Northampton.	Miss Sarah E. Mason, Northampton.
East Sandwich, No. 139,	John F. Carleton, East Sandwich.	Augustus Holway, East Sandwich.	Geo. Parker, East Sandwich.
West Boxford, No. 140,	Wm. K. Cole, West Boxford.	George B Austin, West Boxford.	Matilda B. Lund, West Boxford.
Montague, No. 141,	Frank A. Dean, Montague.	Mrs. R. J. Ball, Montague.	F. A. Rist, Montague.
Bolton, No. 142,	George E. Dow, Bolton.	James G. Dow, Bolton.	Dorcas H. Babcock, Bolton.
Mendon, No. 143,	James J. Nutter, Mendon.	Florence E. Snow, Mendon.	A. W. Gaskill, Mendon.
Franklin, No. 144,	John L. Fisher, City Mills.	Mrs. A. M. Willard, Franklin.	Mrs. Alice A. Duprez, Franklin.
Douglas, No. 145,	Edwin T. Rawson, East Douglas.	Mrs. J. A. Richardson, Douglas.	Jennie F. Williams, East Douglas.
West Newbury, No. 146,	Robert L. Smith, West Newbury.	Mrs. Lizzie M. Newell, West Newbury.	Ethel B. Carlton, West Newbury.
West Springfield, No. 147,	F. H. Plumb, Springfield.	Mrs. H. L. Phelps, West Springfield.	Mrs. H. L. Phelps, West Springfield.
Swansea, No. 148,	Wm. D. Coggeshall, Warren, R. I.	Etta L. Gardner, Swansea Centre.	Chester R. Gardner, South Swansea.
Harvard, No. 149,	John S. Preston, Harvard.	Arthur West, Harvard.	Mrs. Alice S. Bigelow, Harvard.
Concord, No. 150,	O. E. Patch, Concord.	Mrs. Addie Garfield, Concord.	Chas. E. Derby, Concord.
Agawam, No. 151,	Geo. Reed, Agawam.	Mrs. W. H. Harmon, Agawam.	E. L. Covill, Agawam.
East Longmeadow, No. 152,	J. L. Davis, East Longmeadow.	Mrs. Geo. Wood, East Longmeadow.	S. W. Wood, East Longmeadow.
Wilbraham, No. 153,	Edgar C. Clark, Wilbraham.	Mrs. Edgar C. Clark, Wilbraham.	Mrs. W. L. Phelps, Wilbraham.
Haverhill, No. 154,	Asa C. Gordon, Haverhill.	Miss Susan A. Eastman, Haverhill.	Elmira C. Gordon, Haverhill.
Methuen, No. 155,	Geo. E. Crosby, Methuen.	Bessie M. Swan, Methuen.	Mary A. Crosby, Methuen.
West Bridgewater, No. 156,	H. J. Le Lacheur, West Bridgewater.	Walter T. Packard, Campello.	C. R. Packard, West Bridgewater.
Granby, No. 157,	Mrs. W. S. Clark, Granby.	W. S. Clark, Granby.	F. A. Forward, Granby.

MASSACHUSETTS PATRONS OF HUSBANDRY — *Concluded.*

NAME.	MASTER.	LECTURER.	SECRETARY.
"Nemasket" of Middleborough, No. 158,	John G. Paun, Middleborough.	R. B. Simonds, Middleborough.	Annie D. Deane, Middleborough.
"Green River" of Williamstown, No. 159,	S. A. Hickox, South Williamstown.	Mrs. Louise McDonald, Williamstown.	Mrs. A. J. Kellogg, Williamstown.
South Hadley, No. 160,	N. E. Preston, South Hadley.	J. S. Wells, South Hadley.	Chester L. Johnson, Hadley.
"Laurel" of West Newbury, No. 161,	Annie L. Rogers, Newburyport.	Mrs. M. P. Rogers, West Newbury.	Sam Rogers, West Newbury.
Dartmouth, No. 162,	John W. Gifford, South Westport.	Hetty A. Potter, Dartmouth.	J. H. Slocum, Dartmouth.
Dudley, No. 163,	Frank S. Walker, Dudley.	Miss L. E M. Barnes, Dudley.	D. S. Elliott, Dudley.
Ware, No. 164,	J. H. Fletcher, Ware.	C. O. Buffington, Ware.	F. W. Harwood, Ware.
Hampden, No. 165,	Dr. Geo. T. Ballard, Hampden.	Mrs. C. H. Burleigh, Hampden.	Robert Batstone, Hampden.
Wellesley, No. 166,	M. S. Keith, Wellesley Hills.	Richard Cunningham, Wellesley Hills.	Mrs. Abel F. Stevens, Wellesley.
Somerset, No. 168,	Geo. W. Rice, Pottersville.	Joseph Gibbs, Pottersville.	Esther Marble, Pottersville.
Lunenburg, No. 169.	J. L. Harrington, Lunenburg.	May V. Estabrook, Lunenburg.	James Hildreth, Lunenburg.
New Braintree, No. 170,	Frank W. Potter, New Braintree.	S. L. Dickinson, New Braintree.	Mabel F. Snow, New Braintree.
Merrimac, No. 171,	Clarence A. Pettengill, Haverhill.	Irene L. Bancroft, Haverhill.	John J. Woodman, Haverhill.
Ashby, No. 172,	Anson Wetherbee, Ashby.	Mrs. Lida M. Hayward, Ashby.	M. W. Jefts, Ashby.
Hopkinton, No. 173,	W. V. Thompson, Woodville.	Mrs. Mabelle Thompson, Woodville.	Miss Harriet A. Sweet, Hopkinton.
Brookfield, No. 174,	Frank E. Prouty, Brookfield.	Miss Mary L. Eaton, Brookfield.	Miss Cora B. Mitchell, Brookfield.
Athol, No. 175,	Calvin A. Drury, Athol Centre.	Mrs. Lucretia A. Sweet, Athol Centre.	Miss M. J. Tooley, Athol Centre.
"Miller's River" of Orange, No. 176,	L. H. Jerome, Orange.	Mrs. M. E. Giffin, Orange.	M. E. Giffin, Orange.
Sturbridge, No. 177,	E. M. Carpenter, Globe Village.	Mrs. C. E. Ainsworth, Sturbridge.	Mrs. C. L. Edgerley, Sturbridge.
Monson, No. 178,	W. M. Tucker, Monson.	Mrs. J. H. Carpenter, Monson.	F. D. Rogers, Monson.
Ludlow, No. 179,	G. D. Atchinson, Indian Orchard.	Chas. B. Bennett, Ludlow.	Mrs. Lizzie C. Chapman, Indian Orchard.
West Brookfield, No. 180,	Mrs. Mary Fairbanks Holmes, W. Brookfield.	Chas. E. Smith, West Brookfield.	Sadie A. Webb, West Brookfield.
Westport, No. 181,	Wm. E. Brightman, Central Village.	Mary E. Tripp, Westport.	Grace D. Tripp, Westport Point.
Southbridge, No. 182,	Geo. H. Clemence, Globe Village.	Dr. W. G. Reed, Southbridge.	Mrs. S. E. Torrey, Southbridge.
Andover, No. 183,	Milo H. Gould, Andover.	Mrs. John A. Morrill, Andover.	Mrs. Milo H. Gould, Andover.
Topsfield, No. 184,	Albert C. Bradstreet, Topsfield.	George F. Averill, Topsfield.	Wellington Donaldson, Topsfield.
Fitchburg, No. 186,	John H. White, Fitchburg.	Miss Mary A. Corning, Fitchburg.	Jennie M. Hills, Fitchburg.
"Satuit" of Scituate, No 187,	Chas. A. Berry, Norwell.	Mrs. E. M. Sexton, Norwell.	Chas. O. Ellms, Greenbush.

Littleton, No. 188,	B. C. Boyd, Littleton.	Mrs. Nellie F. Johnson, Littleton.	Chas. F. Watts, Littleton Common.
Warren, No. 189,	Wm. E. Patrick, Warren.	A. N. Tuttle, Warren.	H A. Day, Warren.
Bellingham, No. 190,	Orville C. Rhodes, So. Bellingham.	Mrs. D. O. Evans, Caryville.	John J. O'Sullivan, Bellingham.
Chestnut Hill, No. 191,	Wm. A. Dodge, Millville.	Ruth L. Southwick, Mendon.	Mrs. Eleanor R. Tiffany, Millville.
Winchendon, No. 192,	Wm. E. Holden, Winchendon.	Mrs. Wm. E. Holden, Winchendon.	Edson B. Bemis, Winchendon.
Foxborough, No. 193,	James W. Alden, Foxborough.	Geo. W. Scott, Foxborough.	Lewis W. Hodges, Foxborough.
Townsend, No. 194,	Frank J. Knight, Townsend Harbor.	T. E. Flarity, Townsend.	G. A. Wilder, Townsend.
Royalston, No. 195,	C. A. Stimson, Royalston.	Luther Stewart, Athol.	Nellie M. Moore, Royalston.
Easton, No. 196,	David B. Tinkham, North Easton.	Willis P. Holbrook, North Easton.	Mrs. Willis B. Drew, North Easton.
"Brookville" of Holbrook, No. 197,	E. A. G. Hambly, Brookville.	Thomas Fadden, Brookville.	Miss Mabel E. Bard, Brookville.
Leominster, No. 198,	J. N. Page, North Leominster.	S. R. Walker, Leominster.	F. K. Page, Leominster.
Stoughton, No. 199,	Ernest H. Gilbert, Stoughton.	Miss Edna F. Tilden, Stoughton.	Miss Roby M. Gilbert, Stoughton.
Uxbridge, No. 200,	C. A. Barton, Uxbridge.	Mrs. G. Z. Taft, Uxbridge.	Mrs. C. B. Davis, Millville.
Bridgewater, No. 201,	Gould E. Newcombe, Scotland.	Cora I. Andrews, Bridgewater.	Lucius C. Wood, Bridgewater.
Ashburnham, No. 202,	Albert Needham, Ashburnham.	Lilla E. Litch, Ashburnham.	Walter E. Jefts, Ashburnham.
Westminster, No. 203,	W. H. Waterhouse, Westminster.	Mrs. Mabel F. Sawin, Westminster.	Mrs. Julia L. Marshall, Westminster.
Rowley, No. 204,	G. F. Carlton, Millwood.	Chas. A. Houghton, Rowley.	Sophy D. Carlton, Millwood.
"Webster" of Marshfield, No. 205,	Israel H. Hatch, North Marshfield.	Georgie M. Damon, North Marshfield.	Celia J. Wilson, North Marshfield.
Hanover, No. 206,	Harrison L. House, West Hanover.	Helen M. Hayden, North Hanover.	Hattie I. West, North Pembroke.
Tewksbury, No. 207,	Geo. W. Trull, Lowell.	Geo. E. Crosby, Tewksbury.	Mrs. D. K. Vaughan, Tewksbury.
Westford, No. 208,	L. W. Wheeler, Westford.	Mrs. O. V. Robey, Westford.	J. Florence Wilson, Westford.
Hanson, No. 209,	Walter O. Monroe, South Hanson.	Mrs. W. J. Holmes, North Hanson.	S. F. Turner, Hanson.
"Shawmut" of New Bedford, No. 210,	Jas. E. Tripp, Shawmut.	Sadie A. Winslow, New Bedford.	Jas. Whitaker, Shawmut.
Chicopee, No. 211.	Gilbert Billings, Chicopee.	Edna S. Herrick, Chicopee.	Elizabeth I. Chapin, Chicopee.
"Oak Hill" of Attleborough, No. 212,	O. S. Thayer, Attleborough.	Mrs. E. V. Carpenter, Attleborough.	Mrs. A. R. Lewis, Pawtucket, R. I.
"Massapoag" of Sharon, No. 213,	Henry L. Naramore, Sharon.	H. Alberta Felt, Sharon.	Fannie A. Reynolds, Sharon.
Walpole, No. 214,	Julius Guild, Walpole.	Mrs. Ella Sargent, South Walpole.	Miss Edith R. Ellis, Walpole.
Mattapoisett, No. 215,	Edwin F. Hammond, East Mattapoisett.	Mrs. Alice W. Ashley, Mattapoisett.	Asa R. Swift, Mattapoisett.

APPENDIX.

Report of the Delegates to the Farmers' National Congress,*

At Indianapolis, Indiana, 1896.

To His Excellency Roger Wolcott.

Sir: — We are pleased to acknowledge the courtesy of your appointment as delegates from the State of Massachusetts to the Farmers' National Congress, which held its sixteenth annual session at Indianapolis, Ind., on the 10th, 11th and 12th of November, in the year 1896, and submit the following report: —

The Congress assembled in the Representatives Chamber of the State House at Indianapolis, which had been assigned for its meetings, and was called to order at 10 o'clock A.M., on Nov. 10, 1896, by Hon. B. F. Clayton of Iowa, its president.

Delegates numbering about two hundred were present from the following-named States: Massachusetts, Rhode Island, Ohio, Iowa, Illinois, Pennsylvania, Texas, Minnesota, Michigan, Missouri, Kansas, Nebraska, Indiana, Tennessee, Kentucky, Wisconsin, District of Columbia and one from Venezuela, — a less number than was in attendance last year at Atlanta, Ga., but a dignified and influential body of men.

Prayer was offered by Rev. D. R. Lucas of Indianapolis, after which the Congress was welcomed, on behalf of the city, by Mayor Taggart; on behalf of the press, by J. G. Kingsbury of the "Indiana Farmer:" on behalf of the farmers of the State, by Hon. J. G. Offutt of Jackson County, Ind.; and on behalf of the State, by Hon. Claude Matthews, governor of Indiana.

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* This report has been transmitted to the secretary of the State Board of Agriculture by His Excellency the Governor, with the request that it be included in the "Agriculture of Massachusetts."

Replies were made to these warm and cordial addresses of welcome by Secretary John M. Stahl of Illinois and by President B. F. Clayton of Iowa.

President Clayton then delivered his annual address, from which we quote as follows: —

"The natural products of the soil, aided by intelligent and well-directed labor, are the great creative force, the only source from which wealth may be obtained to meet all obligations. The product of the gold and silver mines is only valuable because of the commerce and wealth created from the farms. One year of total failure of the products of the earth, and wreck and ruin, starvation and death would be the inevitable result.

. . . "The science of agriculture and our wonderful mechanical inventions have gone hand in hand in the onward march of this progressive age; but our basal relations remain unchanged, and agriculture must press her claims with even greater force under the new condition of things, as the true source of wealth, and as the solid foundation upon which rests the beautiful and magnificent temple of our success.

. . . "During the last fiscal year of the operations of the former law [tariff law] the agricultural imports on twenty articles the like of which we produce north and south amounted to $65,804,446; during the first calendar year of the operations of the present law the importations of the same articles amounted to $134,068,860, or an increase over the former of $68,264,314. In the exportation of farm products we find the discrepancy still greater in twenty-seven articles produced on the farm. During the fiscal year 1894 we exported farm products to the amount of $907,946,945, while during the calendar year 1895 there were exported of the same products an amount of only $751,833,937, a decrease of $156,113,008. Adding the gain in imports to the loss in exports, and the American farmer loses in one year $224,337,322.

. . . "If these figures be true, a vigorous remonstrance to these schedules should go up from this body, and we should demand that the agricultural department investigate each item. Should protection be the policy of the government, then it should be applied to farm products, and the

agricultural department should recommend to the general government such changes in tariff schedules as will furnish equal protection to the products of the farm."

Then followed a somewhat lengthy paragraph upon trusts and their evil tendencies, summed up as follows: —

"By legislation and by the courts we have settled the great principle that the public have a right to control these trusts, and corporations have accepted the principle. What we want is for the national and State executives to lose no time in laying before Congress and the legislative bodies the evils complained of, and suggest such remedies as will check their future growth.

"We should say to these combinations, Thus far and no farther shalt thou come.

"We should ask for no class legislation; we should demand no favors beyond a legitimate protection to the farm interests, and we should be satisfied with nothing short of the same recognition accorded to all other American industries."

Upon completion of the delivery of the address a committee of five was appointed to examine into its recommendations, and to prepare a memorial to Congress in the line of its suggestions, if deemed advisable. A discussion followed the address, in which many members took part, and lasted until the adjournment for the noon hour, it then being too late to take up new business.

At the afternoon session resolutions were offered in favor of the upbuilding of our merchant marine in the foreign carrying trade; in favor of liberal appropriations for the improvement of our rivers and harbors; for Congress to take measures for the extermination of the gypsy moth; and in favor of international bi-metallism, etc., which were referred to the committee on resolutions, appointed at this session, made up of one delegate from each State, the member from Massachusetts being Mr. Candage, and from Rhode Island Mr. Stockwell, secretary of the Board of Agriculture of Rhode Island, those two being the only New England States represented in the Congress.

A committee on finance was also appointed, of which Mr. Avery of Massachusetts was a member; and a committee on

location for the meeting of the next Congress, of which Mr. Appleton of Massachusetts was made a member.

Judge Wm. Lawrence of Ohio read an interesting and instructive paper, entitled, "How the Farmers' National Congress can become a great political power in aid of non-partisan legislation, State and national."

In his paper the judge urged that thorough organization is necessary to insure success to the farming interests, and that farmers should be awake to the subject of protection to their own products; and illustrated his subject by stating that "the imports on agricultural products for the past year amounted to $200,000,000, the greater part of which could and ought to have been the product of American farms." An animated discussion followed, in which bright men took part, and valuable information upon the subject of agriculture was imparted.

A gentleman from Iowa, Mr. Coffin, stated the annual value of the products of his State, and concluded his remarks by saying: "In the recent political campaign we have heard a great deal about gold, silver and our banking capital; and I want to say that if they were all sunk in the depths of the sea we should soon rally from the disaster, for the value of the product of the cow in this country for a single year is greater than that of all the precious metals and banking capital combined."

Judge Lawrence's paper met with but little opposition, in fact, it was almost unanimously endorsed, and was referred to the committee on memorial to Congress.

Judge E. B. Martindale of Indianapolis, on behalf of the Board of Trade and the Commercial Club of the city, tendered an invitation to the delegates to a reception in the assembly room of the Commercial Club for Wednesday evening, the 11th inst., which was accepted with thanks.

Wednesday Morning, Nov. 11, 1896.

The Congress convened at 10 o'clock A.M., and the first business was a resolution presented by Francis H. Appleton, Esq., of Massachusetts, inviting Ex-President Benjamin Harrison to address the Congress. The resolution was unanimously adopted, and a committee appointed, of which

Mr. Appleton was chairman, to present the compliments of the Congress to the Ex-President, and invite him to address the body.

Resolutions were offered and referred as follows: suggesting S. W. Allerton of Illinois as secretary of agriculture; asking the United States Congress to appoint a corps of engineers to examine and report the feasibility of a ship canal from the lakes to the Mississippi River, connecting the Atlantic with the Gulf by internal communication: that women should be entitled to full suffrage; for equal and just taxation of all property; for the restriction of undesirable immigration; regulating foreign immigration by a per capita tax; for more stringent regulations regarding cattle with tuberculosis; that all farm products be exempt from taxation; in favor of a referendum and a graded land tax; favoring the use of latest and most improved machinery in road building, cities and towns to bear a just proportion of the expense of road building; that the Congress demands that the laws against trusts be enforced and inadequate laws be strengthened.

The committee on resolutions reported favorably on most of these resolutions later, and they were adopted by the Congress.

Papers were read as follows: By A. W. Livingston of Ohio, on "Seed adulteration and its remedies." He urged the farmers to use none but the best seeds, if they expected to gather good crops. Otto Dorner of Wisconsin, a member of the national committee of the L. A. W., read a paper on the subject of good roads, giving illustrations of the benefits to city, town and farm by good roads. Mrs. Katherine Stahl of Illinois read a paper on the "Citizenship of woman." She urged that women are competent in all spheres of life, and her success in the business world as one proof of her proposition; another was the patriotic interest taken by them in the affairs of government, and that it would be wise governmental policy to recognize women. Miss Ada M. Ewing of Iowa read a paper on "The advancement of agriculture in the north-west," which was well received.

An important feature of the day was the introduction to the Congress, by the President, of Señor A. M. Sotaldo, a

credited delegate from Venezuela. He expressed his pleasure at being in an American assembly composed of highly intelligent agriculturists, to whom he brought from his own country expressions not only of friendship but of love and veneration for the United States of America,—the model Venezuela will always be glad to set before her, with the hope that some day she might become second with this country upon this continent. He was made an honorary member of the Congress.

General Roy Stone, of the good roads division of the agricultural department, Washington, D. C., read an interesting paper upon "The silver question after the election," in which he outlined a plan for "an international mint, to be opened under the management of the governments of the chief commercial nations of the world; silver international coins to be issued, known as globe dollars and fractions thereof, bearing their denominations in shillings, francs, etc., on one side and an international symbol with the name of the United States on the other, to be coined and freely used in exchange for gold or its equivalent, or for silver bullion at its market price.

"Bars or blocks of silver to be numbered and stamped with their full international coinage value, for use in bank reserves or for export or domestic transfer. Certificates to be issued on deposit of silver bullion at the market value, or of the proposed coins, bars or blocks.

"The international coins, bars, blocks and certificates to be receivable for public dues, and to be exchangeable for gold at the central mint and its agencies in all countries of the monetary union.

"All profit on the coinage, stampage and issue of certificates for bullion to be placed in a reserved fund, invested in stable government securities, to assure the parity of this currency with gold; the interest arising from such securities to be added to the fund.

"The coinage, stampage or issue of certificates to be curtailed whenever the demand for exchange in gold indicates a redundancy of either.

"The mint and fund to be managed by a commission, consisting of representatives by the governments joining in

the union, one from each country; but all matters of general policy to be determined by a majority in interest, as well as by a majority in numbers; the interest of each nation to be determined at first by the value of its external commerce, and later by the amount of international currency actually taken by its citizens."

The reception to the delegates to the Farmers' National Congress, on the 11th, given by the Indianapolis Board of Trade and Commercial Club, in the rooms of the latter, was largely attended and thoroughly enjoyed.

Thursday, November 12.

The Congress finished its work, which consisted of clearing the docket of the resolutions presented, the greater part of which were passed by the body. Those not before enumerated were: for better mail facilities in the rural districts; for measures to prevent hog cholera and other swine diseases; for the encouragement of the beet and sugar-cane industries; favoring the establishment of a department of commerce by the general government; thanks of the Congress to the governor, mayor, Board of Trade and Commercial Club for their courtesy to the body during its sixteenth annual session in the city of Indianapolis; in favor of wide tires for farm carts and wagons, where practicable; with others not necessary to enumerate.

The committee on finance reported a deficit of $350, upon which it was voted to lay an assessment upon the members of $2 each, to pay the same.

The committee on location of the next Congress reported in favor of St. Paul, Minn., the session to be held the last week in August, 1897. The report was adopted.

A committee was appointed by the Congress to present a memorial to the United States Congress in behalf of the beet sugar industry, to meet in Indianapolis within sixty days, to formulate a report to be presented to the ways and means committee of Congress.

Mr. C. S. Kelsey of Battle Creek, Mich., made an address claiming that beet-sugar raising is practicable and ought to be a leading feature of our agriculture. Walter

J. Quick of Missouri gave his experience and observations recently in Germany on the culture of the sugar beet. A resolution was adopted "favoring a bounty of two cents a pound on all pure cane, maple and beet sugar produced in the United States." The following committee was appointed to advocate this interest: Walter J. Quick, Missouri; E. B. Martindale, Indiana; H. E. Heath, Nebraska; C. S. Kelsey, Michigan; and H. W. Wiley, Washington, D. C.

Ex-President Benjamin Harrison of Indianapolis was presented to the Congress by President Clayton, and proceeded to address the body partly as follows: —

"It is very much the custom of the times, and a natural custom it is, that men of a particular vocation should associate themselves together with a view to promoting their interests, and not selfishly the interests of a few, but the interests of the great class to which they belong; to study the principles that underlie a successful prosecution of a particular calling, and to cultivate fraternal acquaintance.

"The times are full of such associations, and I think they should be encouraged. When men engaged in a particular calling, from high motives, associate themselves together and pursue the high motives in their association, only good can result. But we must not forget that, when we form a lawyers' association or a farmers' association of laboring men, our objects and aims should not be wholly selfish. Indeed, I think I may say that if we were absolutely selfish in our purpose, and thought of our own good, the good of the class and the individual of the class, we should find that good most highly promoted by taking a broad view of things, and by admitting to our deliberations this thought, — that it is not possible for one class to be highly prosperous while all other classes are suffering; that there is an interdependence in all our business and social relations, and this is highly developed in a free government like ours. In other words, we, in a broad sense, prosper together and suffer together.

"I think that the conceit of the farmer has sometimes been unduly promoted when it is said that he is at the bottom of everything, and that he belongs to an independent class; that cities are not of much account; that farms are God's work, and enduring. What would the farm be with-

out the town, and what would the town be without the farm? Cities and towns furnish the population that consume the products of the farm, and the farm furnishes the subsistence of cities and towns. As I heard a friend say the other day: "It is the city for the country and the country for the city, and all for the flag."

A committee of one from each delegation was appointed to write the report of the doings of the Congress to be submitted to the several States, Mr. Candage being named in that connection for Massachusetts.

The memorial ordered to be presented to the Congress of the United States was read and adopted. It contained, among other provisions, the following: —

"In order to give effect to the policy of protection, it should be observed: —

"1. That most of the products of the farm can be supplied by American farmers in sufficient amounts to meet the total needs of the American people. This condition will evidently continue for many years, even with the enlarged home market that may be created by a needed increase in our manufacturing industries.

"2. It is further to be observed that, as to farm products, no combination or monopoly or trust can be organized to extort exorbitant prices. No objection can be properly made as to protection for farm products on the general ground of monopoly.

"3. It results from these considerations that sound policy requires that as to such farm products the protection to be given them should be so ample as to exclude all similar foreign products. When American farmers can supply all needed for domestic consumption, why should they lose a market for any part? Why should foreigners draw gold from the United States in payment for commodities of classes which American farmers can adequately produce? Why not retain the gold, to be paid to American farmers?

"In view of these considerations, this memorial asks the Congress of the United States to give the most ample protection for farm products of the classes mentioned, — that is, protective duties which will give the whole market to Americans.

"Among these products may be named cotton, hemp, flax, wheat, corn, barley, oats, potatoes, hops, dairy products, garden vegetables, poultry and eggs, live stock for use as food, some kinds of tobacco, small fruits, apples and other orchard fruits and hay."

The sheep and wool industry of the country is set forth in the memorial as being sadly in need of protection. It states that: —

"Under normal conditions, the present population of the United States will consume annually 9 pounds per capita of wool, on the unwashed basis, or, in all, 630,000,000 pounds, requiring 110,000,000 sheep for its production. Had the wool tariff of 1867 been kept in force to this time, with improvements adapting it to changed conditions, we would now have a sufficient number of sheep to supply the wool of every kind needed for consumption in this country.

"The tariff was reduced on wool, and under it sheep declined in numbers. In 1890 the flocks of the United States reached a total of 47,223,000, and were increasing at the rate of about 1,000,000 a year. With a value of $2.50 per head in 1892, our flocks were worth $118,057,500. They have been decreasing at the rate of 3,000,000 annually under free wool, and their number had receded, on April 1, 1896, to 36,464,405, with an average value of $1.70 a head, — a loss in numbers of more than 10,000,000 in three years, and in value a sum over $60,000,000."

Congress is asked in the memorial to pass the bill presented by the National Wool Growers' Association in December, 1895, revised and printed in July, 1896, in the "Quarterly Bulletin" of that association.

"It proposes a duty of 12 cents a pound on merino wool and wools of the mutton breeds of sheep unwashed; on other wools, 8 cents per pound; double duty on all if washed, and treble if scoured. Australian and similar wools of light shrinkage in scouring, as shown in native condition, shall be deemed washed; that wool in any other ordinary condition of fleece shall be subjected to double duty; and defines what shall be deemed scoured wool."

The business for which the sixteenth annual session had been convened having been completed, after a vote of thanks to the officers was passed, a vote to adjourn was carried, the

president's gavel fell, and with hasty adieus the members separated.

The delegates from New England (three from Massachusetts and one from Rhode Island) wielded an influence in the Congress second to none, notwithstanding their small number and territory represented.

They presented the following resolutions, which were unanimously adopted: —

Resolved, That the Farmers' National Congress is in favor of the upbuilding of our merchant marine in the foreign carrying trade, and urges upon the Congress of the United States the necessity of enacting such laws as will best promote that object, so that American ships, the product of labor in our own shipyards, sailing under our own flag, and owned, officered and manned by Americans, may regain their rightful place in the carrying of our foreign commerce.

Resolved, That the Farmers' National Congress favors improving the harbors of the Atlantic, Gulf and Pacific coasts, the lakes and rivers of the interior, and the speedy completion of the harbors of refuge now in process of construction; as they mean cheaper transportation, cheaper food, fuel, clothing and supplies generally to every inhabitant of our country; therefore it urges the Congress of the United States to make liberal appropriations for these objects, in the interest of a wise economy and a broad humanity.

Resolved, That the Farmers' National Congress views with alarm the ravages made by the gypsy moth upon the trees and foliage of the New England States, and urges the United States Congress to examine into the subject, and to take such measures for the extermination of the pest as may seem wise, as its spread over the country would prove to be a national disaster.

Whereas, It is asserted that injustice to the farmer and land owner in matters of taxation is permitted under the laws of many of the States of the Union, which discriminate in favor of chartered corporations, therefore, be it

Resolved, That the Farmers' National Congress favors equal and just taxation of all property, and that chartered corporations should be taxed upon the market value of their shares by the State or States granting their charters, at the average rate of taxation for such State or States, less the value of their real estate and machinery, which should be taxed by the assessors where located; the same to be paid into the State treasury and credited to the cities, towns or counties where such shareholders reside, in proportion to their several holdings.

The value of these sessions of the Farmers' National Congress is made apparent by the diversity of public questions which come before it for discussion and action, and by the practical questions affecting the community at large which it seeks to lay before Congress and the State Legislatures for their action.

Some of the States make provision for the payment of the expenses of their delegates, while others do not; but it seems to your delegates that a provision made for paying the expenses of a limited number of delegates would be wise, as it would insure a representation in the body, a desirable consideration in itself.

A closing paragraph or two relating to Indiana and Indianapolis. Indiana was settled in the last half of the eighteenth century, and was admitted into the Union of States in 1816. It has an area of 33,809 square miles, divided into 92 counties, and in 1890 it contained a population of 2,192,404. It is a fertile and productive agricultural State. The acreage under wheat cultivation for the year 1896, according to the report of the Bureau of Statistics, was 2,862,236, — an increase over 1895 of 144,048 acres; producing 24,574,853 bushels, — an average of 8.5 bushels to the acre. The corn product for the same period was 3,706,146 bushels; oats, 1,098,700; rye, 148,899; barley, 33,222; potatoes, 1,451,272; pigs enumerated, 1,159,939; hogs, 1,452,715; sheep, 832,538; lambs, 511,578; wool clip, 4,691,883 pounds; horses, 692,917; mules, 60,075; milch cows, 468,096; and all other cattle, 495,066. The productiveness of the State of Indiana is a marvel to one who has spent his life in New England, where climate and soil are less favorable for the production of agricultural staples.

Indianapolis, the capital of Indiana, and its chief city, is situated in the centre of the State, upon an extensive level plain; was first settled in 1819; made the capital and laid out in 1821; chartered as a town in 1836 and as a city in 1847. It is an important railroad centre, has a large trade in grain and other agricultural products; contains many houses of commercial importance, commodious business structures, good hotels and many fine private dwellings. It

has broad streets, paved with asphalt, good wide sidewalks, a fine trolley street-car system, sewerage, water, electric lights, natural gas for heating and lighting, and a population of 105,436 in 1890, which in 1896 is claimed to be 125,000.

Its public buildings are a fine State house, recently built at a cost of $2,000,000; a court house, city hall, a banking building modelled after the Bank of England, and others, and a monument to the heroes of the revolution, war of 1812, Mexican war and war of the rebellion. This monument is 268 feet in height, and from it may be had an extensive view of a level plain, without hill or elevation in any direction to intercept the boundary of the distant horizon. It reminds one of the outlook from the mast head of a ship at sea, with this difference: there one beholds a world of waters with the ship below him; here a vast prairie resembling the open sea in extent, with the city spread out from the base of the monument, its streets and buildings plainly marked. Washington Street, its chief avenue and thoroughfare, one hundred and twenty feet in width, upon which are located many of the prominent retail stores, shops and business places, is seen extending the length of the city.

Indianapolis is a place of great activities, prosperous and progressive, its people are intelligent, frank, open-hearted and hospitable to a marked degree.

R. G. F. CANDAGE,
For the Delegates.

ANNUAL REPORT

OF THE

BOARD OF CATTLE COMMISSIONERS,

IN ACCORDANCE WITH SECTION 51 OF CHAPTER 491
OF THE ACTS OF 1894.

JANUARY 11, 1897.

REPORT

OF THE

BOARD OF CATTLE COMMISSIONERS.

To the Honorable Senate and House of Representatives.

In conformity to section 51 of chapter 491 of the Acts of the year 1894, the Board of Cattle Commissioners presents the following report of its work for the year 1896.

The law of 1894 has continued to be the basis of the work of the Board during the year, except as it was modified by the Legislature of 1896. The work has been continued under the following heads: —

First. — The supervision and direction of the local inspectors of animals and provisions, appointed by cities and towns under the provisions of chapter 491 of the Acts of 1894.

Second. — The examination of all animals quarantined by local inspectors as suspected of being afflicted with contagious disease.

Third. — The examination of cattle coming into the markets at Brighton, Watertown and Somerville from without the State for sale, and without certificates of having passed the tuberculin test before entering the State.

Fourth. — The examination of cattle coming from without the State upon special permit.

Fifth. — The examination of stables, etc., with a view to secure better sanitary conditions, for the prevention of disease.

Sixth. — The conduct of laboratory and stable experiments, to determine various problems connected with the work of the Board.

The work of the Board was quite thoroughly examined during the last session of the Legislature by the joint committee on agriculture, in a hearing which occupied several protracted sessions. The critics of the Board presented statements and criticisms in support of bills which they presented, restricting the use of tuberculin, changing the methods of local inspection, and abolishing the commission

and transferring its duties to the State Board of Agriculture. The only result was the continuance for another year of the provision of the statute limiting the use of tuberculin to tests of foreign cattle at the public markets, and of animals reported as suspicious by local inspectors. The testing of cattle in response to voluntary requests was forbidden. In view of the conditions prevailing, the commission did not seriously oppose the continuance of the restriction of the use of tuberculin, although it did not meet their approval. A large number of the leading farmers, cattle owners and agricultural experts in the State testified their approval of the methods of the commission and of their use of tuberculin; and several leading veterinarians from other States voluntarily appeared to urge the committee to sustain the commission, they believing that its methods and plans were wise and necessary, and for the public good.

For several months following the date of the last annual report the work of the Board was hindered by lack of means for testing and disposing of the cattle reported by the local inspectors as suspected, on physical examination, of tuberculosis.

The fact of the rapid accumulation of this class of cases was set forth in our last annual report, together with the statute which prevented our prompt action upon them, which is section 37 of chapter 16 of the Public Statutes, as follows: —

No public officer shall make purchases or incur liabilities in the name of the Commonwealth for a larger amount than that which has been appropriated by law for the service or object for which such purchases have been made or liabilities incurred; and the Commonwealth shall be subject to no responsibility for the acts of its servants and officers beyond the several amounts duly appropriated by law.

As stated in our last report, "The commission considered it more desirable to incur the expense of making the examinations as soon as possible after receipt of the notice, freeing such animals as were found not to be tuberculous, and keeping the others in quarantine until it became possible, by

means of a further appropriation, to compensate the owners for their losses and destroy the animals."

To prevent as much as possible this unnecessary expense, the Board adopted General Order No. 12, and forwarded it to all the inspectors, in the following communication: —

COMMONWEALTH OF MASSACHUSETTS.

BOARD OF CATTLE COMMISSIONERS,
SECRETARY'S OFFICE, 52 VILLAGE STREET, BOSTON, Feb. 3, 1896.

To Inspectors of Animals and Provisions.

The Board of Cattle Commissioners regrets having to inform you that the appropriation of money for carrying out the provisions of chapter 491 of the Acts of 1894, as amended by chapter 496 of the Acts of 1895, has become exhausted, and that because of this fact the Board is compelled, under the provisions of the statutes, to do everything in its power to stop further expenditures under the said acts.

In accordance with these facts, at a meeting of the Board held on Jan. 29, 1896, the following order was passed: —

General Order No. 12.

It is hereby ordered that the further inspection of animals directed to be made by the inspectors of animals and provisions for the several cities and towns of this Commonwealth, under section 4 of chapter 491 of the Acts of 1894, as amended by section 1 of chapter 496 of the Acts of 1895, and in accordance with General Order No. 6 of this Board, communicated to you in a circular letter dated July 22, 1895, shall be stopped until further notice from this Board.

FREDERICK H. OSGOOD, *Chairman.*
CHARLES P. LYMAN, *Secretary.*
MAURICE O'CONNELL,
LEANDER F. HERRICK,
CHARLES A. DENNEN,
Board of Cattle Commissioners.

In spite of these precautions, however, before the appropriation authorized by the Legislature was available there were 1,043 such cattle in quarantine, scattered through all parts of the State. These animals had been kept in quarantine, awaiting the appropriation of funds by the Legislature, at an expense to the State of $28,223.43. On June 5 the

work of cleaning up this accumulation was begun, and it was completed as soon as possible.

Under the provisions of the statutes, the executive officials of all cities and towns in the State are required to appoint inspectors of animals and provisions to have general supervision of the inspection of domestic animals within the limits of their respective cities and towns, acting under oath. The duties of these inspectors are to examine, at the time of slaughter, all neat stock, sheep and swine slaughtered at slaughter houses licensed under the provision of law, to make inspections of neat cattle, sheep and swine at such times as this Board shall designate, and to make special inspection from time to time of animals reported as suspected of having any of the contagious diseases named in the act.

Under this provision the executives of the cities and towns have reported to the Board the following list of inspectors as serving during the year: —

Abington, ...	John M. Chamberlain.
Acton, ...	Moses A. Reed.
Acushnet, ...	Philip A. Bradford.
Adams, ...	Andrew G. Potter.
Agawam, ...	Edwin Leonard.
Alford, ...	Samuel K. Williams.
Amesbury, ...	Edwin S. Worthen.
Amherst, ...	Henry E. Paige.
Andover, ...	Chas. H. Newton.
Arlington, ...	H. L. Alderman.
Arlington, ...	Alonzo S. Harriman.
Ashburnham, ...	Chas. W. Whitney, 2d.
Ashfield, ...	Walter G. Lesure.
Ashfield, ...	Homer S. Day.
Ashby, ...	Chas. C. Damon.
Ashland, ...	Samuel D. Witt.
Ashland, ...	Arthur E. White.
Ashland, ...	Edmund A. Stone.
Athol, ...	Oscar F. Stearns.
Attleborough, ...	T. L. Swift.
Avon, ...	Chas. E. May.
Ayer, ...	William N. Dudley.
Auburn, ...	Emery Stone.
Barnstable, ...	Alfred Crocker.
Barnstable, ...	John J. Harlow.
Barre, ...	John L. Smith.
Becket, ...	Edwin Lee.

Bedford,	Henry Wood.
Belchertown,	Guy C. Allen.
Bellingham,	Carroll E. White.
Belmont,	Benj. A. Harris.
Berkley,	Chas. F. Paull.
Berkley,	Eliphalet Terry.
Berlin,	Robert B. Wheeler.
Bernardston,	Chas. Bowker.
Beverly,	Horace D. Lambert.
Billerica,	William H. Hutchins.
Blackstone,	Daniel H. Cooney.
Blackstone,	Elias M. Billings.
Blandford,	Janus W. Knox.
Blandford,	William H. Oatley.
Blandford,	E. B. Gibbs.
Bolton,	Henry F. Haynes.
Boston,	Alexander Burr.
Boston,	George W. Roberts.
Bourne,	Noble P. Swift.
Boxborough,	P. W. Cunningham.
Boylston,	George E. Gleason.
Boxford,	George B. Killam.
Boxford,	Chas. A. Andrew.
Bradford,	Doane Coggswell.
Braintree,	James M. Cutting.
Brewster,	James S. Paine.
Bridgewater,	Calvin Pratt.
Brimfield,	Porter A. Parker.
Brockton,	Simeon Mitchell.
Brockton,	Lucas W. Alden.
Brookfield,	Lewis Thresher.
Brookline,	Alexander Marshall.
Buckland,	William R. Shaw.
Burlington,	A. S. Lamb.
Cambridge,	Chas. E. Hadcock.
Canton,	Patrick J. Cronan.
Carlisle,	George P. Davis.
Carver,	Fred A. Ward.
Charlemont,	Horace Temple.
Charlton,	Stephen Hammond.
Chatham,	Isaac B. Young.
Chelmsford,	E. C. Perham.
Chelsea,	William Stinson.
Cheshire,	William P. Bennett.
Chester,	Daniel B. Holcomb.
Chester,	Edward L. Higgins.
Chesterfield,	George W. Rogers.
Chesterfield,	Clayton N. Rhodes.
Chicopee,	Irving H. Elmer.

Chicopee, ...	Thomas Goodwin.
Chilmark, ...	Freeman Hancock.
Clarksburg, ...	James Mixer.
Clinton.	Chas. H. Laselle.
Cohasset, ...	Caleb F. Nichols.
Colrain, ...	Hiram S. Meecham.
Concord, ...	Horace Tuttle.
Conway, ...	Gordon H. Johnson.
Cottage City, ...	E. G. Beetle.
Cummington, ...	Edward F. Warner.
Cummington, ...	Myron D. Trow.
Cummington, ...	Finley V. Bates.
Dalton, ...	William C. Brague.
Dalton, ...	William Miller.
Dana, ...	L. S. Blackmer.
Dana, ...	Alfred E. Doane.
Danvers, ...	Chas. S. Moore.
Dartmouth, ...	Chas. W. Howland, 2d.
Dartmouth, ...	Chas. H. Negus.
Dedham, ...	Creighton Colburn.
Deerfield, ...	D. A. Hawks.
Deerfield, ...	Edward D. Jewett.
Dennis, ...	Chas. E. Baker.
Dennis, ...	Edwin Whittemore.
Dighton, ...	William H. Walker.
Dighton.	Edmund Hathaway.
Dighton, ...	George A. Clark.
Douglas, ...	James Dermody.
Douglas, ...	E. P. Heath.
Dover, ...	S. O. Fowle.
Dracut, ...	Clement A. Hamblet.
Dudley, ...	Monroe W. Ide.
Dunstable, ...	Franklin M. Tolles.
Duxbury, ...	George Bradford.
Duxbury, ...	John K. Parker.
East Bridgewater, ...	W. T. Greene.
East Longmeadow, . . .	Edwin Indicott.
Eastham, ...	J. Bradley Steele.
Easthampton, ...	Fordyce Whitmarsh.
Easton, ...	E. R. Hayward.
Edgartown, ...	Christopher R. Beetle.
Egremont, ...	Theodore S. Baldwin.
Enfield, ...	William H. Bush.
Enfield, ...	Albert R. House.
Erving, ...	Frank W. Loveland.
Essex, ...	Chas. A. Burnham.
Everett, ...	George Peabody.
Fairhaven, ...	E. G. Grinnell.
Fall River, ...	Hilaire Bisaillon.

Falmouth,	Francis A. Nye.
Falmouth,	B. C. Cahoon.
Falmouth,	Henry C. Lewis.
Falmouth,	Asa P. Tobey.
Falmouth,	T. Lawrence Swift.
Fitchburg,	Otis F. Lord.
Florida,	Nathan W. Kemp.
Foxborough,	A. W. Draper.
Foxborough,	B. P. Crocker.
Framingham,	William R. Morrow.
Franklin,	Thomas L. Martin.
Freetown,	Palo Alto Pierce.
Freetown,	James Webb.
Gardner,	Frank B. Page.
Gardner,	Augustus S. Cleaves.
Gay Head,	Samuel J. Haskins.
Georgetown,	Samuel T. Poor.
Georgetown,	J. Winfred Yeaton.
Gill,	John L. S. Moore.
Gloucester,	Daniel G. Cressy.
Goshen,	Willis A. Smith.
Gosnold,	Joshua W. Tilton.
Grafton,	Perley Goddard.
Granby,	George L. Witt.
Granby,	Homer C. Taylor.
Granby,	Samuel A. Taylor.
Granville,	George W. Cone.
Granville,	Cyrus W. Ives.
Great Barrington,	Edwin Hurlburt.
Greenfield,	M. L. Miner.
Greenwich,	Walter N. Glazier.
Groton,	Samuel P. Williams.
Groveland,	Nathan Longfellow.
Hadley,	Homer L. Cowles.
Hadley,	Chas. H. Hunt.
Halifax,	Jabez P. Thompson.
Hamilton,	George E. F. Dane.
Hampden,	M. N. Warren.
Hancock,	James S. Goold.
Hanover,	Edwin B. Dwelley.
Hanson,	Ezra White.
Hardwick,	John N. Hillman.
Harvard,	M. A. Farnsworth.
Harwich,	John A. Baker.
Hatfield,	E. S. Warner.
Haverhill,	Grantley Bickell.
Hawley,	L. W. Temple.
Heath,	V. D. Thompson.
Hingham,	Robert F. Robinson.

Hinsdale,	Frank C. Phillips.
Holbrook,	Z. P. Jordan.
Holden,	Edward W. Merrick.
Holland,	A. J. Bagley,
Holliston,	I. A. Smith.
Holyoke,	Bernard S. Bigelow.
Hopedale,	Waldo Phipps.
Hopkinton,	W. W. Claflin.
Hubbardston,	John H. Burtch.
Hudson,	A. L. Cundall.
Hull,	Harvey T. Litchfield.
Huntington,	Frank T. Clapp.
Huntington,	Herman Burr.
Huntington,	Chas. H. Strong.
Hyde Park,	Joseph M. Kiggen.
Ipswich,	Edward Dole.
Kingston,	E. Elbridge Atwood.
Lakeville,	Isaac Sampson.
Lancaster,	Henry H. Hosmer.
Lanesborough,	F. D. Deming.
Lanesborough,	William P. Talcott.
Lawrence,	John F. Winchester.
Lawrence,	Valentine Sellers.
Lee,	John McAllister.
Leicester,	Edward Warren.
Lenox,	Chas. C. Flint.
Leominster,	George M. Kendall.
Leverett,	O. C. Marvell.
Lexington,	Chas. M. Parker.
Leyden,	Ezra Foster.
Lincoln,	Chas. S. Smith.
Littleton,	J. H. Murray.
Longmeadow,	Jairus R. Kibbe.
Lowell,	W. A. Sherman.
Ludlow,	A. L. Bennett.
Lunenburg,	Chas. E. Woods.
Lunenburg,	Micah M. Boutwell.
Lynn,	William E. Welts.
Lynnfield,	William R. Roundy.
Malden,	George R. Frye.
Manchester,	H. D. Lambert.
Mansfield,	Joseph N. Tibbetts.
Marblehead,	Amos P. Alley.
Marion,	George F. Richards.
Marlborough,	H. R. Stanhope.
Marshfield,	F. W. Hatch.
Mashpee,	Darius Coombs
Mattapoisett,	David H. Cannon.
Maynard,	Joel F. Parmenter.

Medfield, ...	Francis D. Hamant.
Medford, ...	Henry F. Moore.
Medway, ...	Edward Whitney.
Melrose, ...	William H. Dole.
Mendon, ...	Albert W. Gaskill.
Merrimac, ...	H. J. Cushing.
Methuen, ...	Edwin J. Castle.
Middleborough, ...	James A. Burgess.
Middlefield, ...	John P. Bryan.
Middleton, ...	Andrew W. Peabody.
Milford, ...	Waldo Phipps.
Millbury, ...	Henry W. Carter.
Millis, ...	Moses C. Adams.
Milton, ...	James Spencer.
Monroe, ...	A. H. Goldthwaite.
Monson, ...	W. H. Bugbee.
Monson, ...	Hiram D. Osborne,
Montague, ...	George H. Goddard.
Montague, ...	F. H. Giles.
Monterey, ...	Chas. W. Gregory.
Montgomery, ...	Samuel W. Coe.
Mount Washington, . . .	Alfred S. Spurr.
Nahant, ...	Robert L. Cochran.
Nantucket, ...	Albert Easton.
Natick, ...	Walter P. Mayo.
Natick, ...	C. A. Partridge.
Needham, ...	S. O. Fowle.
New Ashford, ...	Van Ness Mallery.
New Bedford, ...	D. C. Ashley.
New Braintree, ...	Chas. A. Felton.
New Marlborough, ...	George A. Stevens.
New Marlborough, ...	L. P. Keyes.
New Salem, ...	Willard Putnam.
Newbury, ...	Asa Pingree.
Newburyport, ...	George W. Knight.
Newton, ...	J. R McLaughlin.
Norfolk, ...	Andrew R. Jones.
North Adams, ...	A. A. McDonnell.
North Andover, ...	George S. Fuller.
North Attleborough, . . .	Asa A. Newell
North Attleborough, . . .	G. B. Draper.
North Attleborough, . . .	T. L. Swift.
North Brookfield, ...	A. O. Boyd.
North Brookfield, ...	B. F. Barnes.
North Reading, ...	F. Howard Mosman.
Northampton, ...	Dwight A. Horton.
Northborough, ...	F. H. Atwood.
Northbridge, ...	George F. Nilsson.
Northbridge, ...	John Gunn.

Northbridge, ...	W. A. Bean.
Northfield, ...	R. C. Ward.
Northfield, ...	Frank E. Heald.
Norton, ...	Lester D. Blandin.
Norton, ...	Owen E. Walker
Norwell, ...	J. Warren Foster.
Norwell, ...	Edwin C. Briggs.
Norwell, ...	Ashburton W. Pierson.
Norwood, ...	Albert Fales.
Oakham, ...	H. P. Austin.
Orange, ...	Amos Blodgett.
Orleans, ...	F. W. Higgins.
Orleans, ...	Edmund Linnell.
Orleans, ...	Gilbert A. Dodge.
Otis, ...	Edwin L. Downs.
Otis, ...	Alfred D. Jones.
Oxford, ...	F. L. Snow.
Palmer, ...	E. W. Phinney.
Paxton, ...	H. P. Bemis.
Peabody, ...	John E. Herrick.
Peabody, ...	Cyrus T. Batchelder.
Peabody, ...	Chas. Davis.
Pelham, ...	Eugene P. Bartlett.
Pembroke, ...	Clifford I. Rogers.
Pepperell, ...	Samuel P. Bancroft.
Peru, ...	King C. Phillips.
Petersham, ...	S. C. Goddard.
Phillipston, ...	F. J. Kendall.
Pittsfield, ...	George N. Kinnell.
Plainfield, ...	D. H. Gould.
Plainfield, ...	Edwin A. Atkins.
Plymouth, ...	Chas. B. Harlow.
Plymouth, ...	William T. Pierce.
Plympton, ...	Howard O. Bonney.
Prescott, ...	Elmer M. Aiken.
Prescott, ...	James D. Barnes.
Princeton, ...	George Mason, Jr.
Provincetown, ...	Daniel F. Lewis.
Quincy, ...	Timothy F. Ford.
Randolph, ...	A. L. Chase.
Raynham, ...	James O. Sturtevant.
Raynham, ...	Cyrus Leonard.
Reading, ...	Milton G. Parker.
Rehoboth, ...	Clarence J. Kingsbury.
Rehoboth, ...	John W. Chase.
Rehoboth, ...	Albert R. Lewis.
Revere, ...	Edwin S. Plaisted.
Richmond, ...	W. H. Branch.
Rochester, ...	Allen G. Ashby.

Rockland,	Chas. Winslow.
Rockport,	Alvin Sanborn.
Rowe,	E. M. Upton.
Rowley,	Daniel H. Hale.
Rowley,	J. Scott Todd.
Royalston,	George E. Peirce.
Royalston,	Joseph Stewart.
Royalston,	Eugene Twitchell.
Russell,	S. S. Shurtleff.
Rutland,	F. G. Bartlett.
Salisbury,	Samuel P. Merrill.
Salem,	Fred Saunders.
Sandisfield,	Chas. H. Callender.
Sandisfield,	H. S. Manley.
Sandwich,	Samuel H. Nye.
Saugus,	Arthur W. Sawyer.
Savoy,	Linus E. Perry.
Savoy,	Milton A. Bliss.
Scituate,	Caleb L. Damon.
Seekonk,	Olney Greene.
Seekonk,	Lowell M. Cole.
Seekonk,	Robert Woodward.
Sharon,	A. W. Draper.
Sheffield,	Henry C. Clark.
Sheffield,	Edwin L. Boardman.
Shelburne,	Lewis T. Covell.
Shelburne,	Alfred F. Skinner.
Shelburne,	H. L. Warfield.
Sherborn,	Jasper J. Smart.
Sherborn,	William A. Adams.
Shirley,	Samuel B. Scott.
Shrewsbury,	George L. Plympton.
Shrewsbury,	Jubal A. Gleason.
Shrewsbury,	David Barnes.
Shutesbury,	Oscar H. Shaw.
Somerset,	Thomas A. Francis.
Somerville,	Chas. M. Berry.
South Hadley,	Horace W. Gaylord.
Southampton,	Henry E. Coleman.
Southampton,	Michael Norris.
Southborough,	William H. Buck.
Southbridge,	Henry A. Morse.
Southwick,	Chas. W. Talmage.
Spencer,	Abraham Capen.
Springfield,	James Kimball.
Sterling,	W. S. Walker.
Stockbridge,	Marshall S. Heath.
Stockbridge,	John M. Buck.
Stoneham,	George H. Allen.

Stoughton,	James Murphy.
Stow,	Lewis Parks.
Sturbridge,	William Whittemore.
Sudbury,	Nahum Goodnow.
Sudbury,	George A. Haynes.
Sudbury,	Hiram Haynes.
Sunderland,	George P. Smith.
Sutton,	Edward A. Welch.
Sutton,	P. D. King.
Swampscott,	Samuel A. Spaulding.
Swanzey,	David B. Gardner.
Swanzey,	Anson L. Barney.
Swanzey,	Arthur W. Weaver.
Taunton,	Walter H. Haskell.
Templeton,	S. E. Greenwood.
Templeton,	W. F. Robie.
Tewksbury,	George W. Trull.
Tisbury,	Henry C. Norton.
Tolland,	Bentley Pratt.
Tolland,	C. N. Marshall.
Topsfield,	Eugene L. Wilder.
Townsend,	John N. Going.
Truro,	Josiah F. Rich.
Tyngsborough,	Franklin N. Tolles.
Tyringham,	Joseph Jones.
Upton,	George D. Whitney.
Upton,	Benj. A. Jourdan.
Uxbridge,	Chas. E. Seagrave.
Wakefield,	Henry C. Perry.
Wales,	W. W. Eager.
Walpole,	George S. Fuller.
Waltham,	William E. Peterson.
Ware,	A. A. Etienne.
Wareham,	Samuel M. Crocker.
Wareham,	James W. Hurley.
Warren,	Marcus Burroughs.
Warwick,	Gilbert Maynard.
Washington,	Chas. E. Schultz.
Watertown,	George W. Pope.
Wayland,	Thomas W. Frost.
Wayland,	Thomas Bryant.
Webster,	E. M. Frissell.
Wellesley,	S. O. Fowle.
Wellfleet,	George W. Nickerson.
Wendell,	George A. Lewis.
Wenham,	Henry Alley.
West Boylston,	John F. Knight.
West Bridgewater,	David R. Simmons.

West Brookfield, ...	E. B. Lynde.
West Newbury, ...	Alfred L. Moore.
West Springfield, . . .	M. H. Bidwell.
West Springfield, . . .	Henry A. Sibley.
West Stockbridge, . . .	R. R. Bissell.
West Tisbury, ...	William Look.
West Tisbury, ...	William B. Luce.
Westborough, ...	Henry A. Gilmore.
Westfield, ...	William Arnold.
Westford, ...	George T. Day.
Westford, ...	A. P. Richardson.
Westhampton, ...	William J. Lyman.
Westhampton, ...	A. D. Montague, Jr.
Westminster, ...	M. D. Whitney.
Westminster, ...	E. L. Burnham.
Westminster, ...	A. E. Mossman.
Weston, ...	E. O. Clark.
Westport, ...	Edward S. Smith.
Westport, ...	Theodore B. Peirce.
Weymouth, ...	Hiram E. Raymond.
Weymouth, ...	Chas. E. Bicknell.
Whately, ...	Irving Allis.
Whitman, ...	Owen F. Bumpus.
Wilbraham, ...	Lyman Fiske.
Williamsburg, ...	George W. Lawley.
Williamstown, ...	Joseph D. Patterson.
Wilmington, ...	H. Allen Sheldon.
Winchendon, ...	William A. Deland.
Winchester, ...	Wm. B. Simonds.
Windsor, ...	H. Ward Ford.
Windsor, ...	G. L. Miner.
Winthrop, ...	C. Porter Tewksbury.
Woburn, ...	Edward P. McKenna.
Woburn, ...	James N. Stuart.
Worcester, ...	John P. Streeter.
Worcester, ...	J. Warren Ellsworth.
Worcester, ...	Thomas Monahan.
Worthington, ...	Albert J. Randall.
Worthington, ...	Horace F. Bartlett.
Wrentham, ...	Elisha M. Brastow.
Wrentham, ...	George B. Ware.
Yarmouth, ...	James Lack.
Yarmouth, ...	Isaiah Homer.
Yarmouth, ...	Isaiah Crowell.

The following are the orders relating to inspection of animals issued by the Board during the current year: —

COMMONWEALTH OF MASSACHUSETTS.

BOARD OF CATTLE COMMISSIONERS,
SECRETARY'S OFFICE, 52 VILLAGE STREET, BOSTON, Sept. 30, 1896.

To Inspectors of Animals and Provisions.

The Board of Cattle Commissioners begs to inform you that it desires to have a complete general inspection of neat cattle at once, and that such examination be completed soon enough to enable it to publish a complete result of the same in the coming annual report for 1896. In order to accomplish this, the following order was passed at a meeting held on Sept. 29, 1896: —

General Order No. 14.

In accordance with the authority conferred upon us by section 4 of chapter 491 of the Acts of 1894, as amended by section 1 of chapter 496 of the Acts of 1895, you are hereby ordered to make an inspection of all neat cattle within your district. Such inspection is to be commenced on October 1, or as soon thereafter as possible, and to be continued with all possible despatch until finished, or until December 1, at which time it is hereby ordered closed.

It is further ordered that the returns directed by law to be made to this office shall be so made, on blank form No 1, as often as once in each week during the whole period of inspection, in order that a close record may be kept of the number of animals that have been examined in each town as the work progresses. All inspectors' reports must be sent to the Boston office on or before Dec. 5, 1896.

We further beg leave to call your particular attention to that provision of section 4 of chapter 491 of the Acts of 1894, as amended by section 1 of chapter 496 of the Acts of 1895, which requires that all inspectors of animals and provisions throughout the Commonwealth "shall immediately inspect any and all domestic animals and any barn, stable or premises where any such animals are kept, whenever directed to do so by the Board of Cattle Commissioners, or any of its members." In accordance with this provision, this Board, at a meeting held on the twenty-ninth day of September, 1896, passed the following order: —

General Order No. 15.

All inspectors throughout the Commonwealth are hereby directed to make a thorough examination of all barns, stables and premises where domestic animals are kept, and to report the results of these examinations upon form No. 20. It is further directed that this examination shall be made at the same time at which the regular general examina-

tion of the neat stock is made; and that the reports concerning the same shall be forwarded to this office, together with the reports of the examination of neat stock, on or before Dec. 5, 1896.

FREDERICK H. OSGOOD, *Chairman.*
CHARLES P. LYMAN, *Secretary.*
MAURICE O'CONNELL,
LEANDER F. HERRICK,
CHARLES A. DENNEN,
Board of Cattle Commissioners.

NOTICE. — A book containing a number of the required forms will be forwarded to you under separate cover. If more are required, they will be sent upon application.

COMMONWEALTH OF MASSACHUSETTS.

BOARD OF CATTLE COMMISSIONERS,
52 VILLAGE STREET, BOSTON, Dec. 2, 1896.

GENERAL ORDER NO. 16.

To the Inspectors of Animals and Provisions.

SIR: — Inasmuch as the financial year closes on December 15, and the report of the Board of Cattle Commissioners must be in the hands of the Legislature on or before January 10, and you have not stopped your inspection, in accordance with General Order No. 14, sent you on September 30, which stated that such inspection "is to be commenced on October 1, or as soon thereafter as possible, and to be continued with all possible despatch until finished, or until December 1, at which time it is hereby ordered closed," it was this day voted that no further inspection of animals should be made by you, or any animals quarantined except by instruction from the Board of Health of your city or town, as provided by section 30 of chapter 491 of the Acts of 1894, until the tenth day of January, 1897.

FREDERICK H. OSGOOD, *Chairman.*
L. F. HERRICK, *Secretary.*
JOHN M. PARKER,
MAURICE O'CONNELL,
C. A. DENNEN.

The regular inspection was ordered by the Board September 30, to begin October 1 and to be closed on December 1. Under this order the inspectors of the cities and towns have reported 8,969 animals suspected of contagious disease, — tuberculosis. These were subjected to the tuberculin test, and 4,694 were condemned and destroyed.

The following table shows the number of animals quarantined in the cities and towns; it also shows the number condemned and the amounts paid, but it does not include 550 animals which have been condemned and warrants for which are now in the process of settlement. The table also gives the State tax and number of neat cattle over one year old, as shown by the assessors' returns, May 1, 1896, in the respective cities and towns.

CITY OR TOWN.	Neat Cattle Assessed.	Number Tested.	Number Condemned.	Amount Awarded.	State Tax.
Abington,	272	2	–	–	$1,750 00
Acton,	1,484	38	29	$1,011 15	1,050 00
Acushnet,	437	–	–	–	437 50
Adams,	769	29	3	90 00	2,695 00
Agawam,	1,308	22	12	402 50	945 00
Alford,	299	–	–	–	157 50
Amesbury,	399	20	7	215 00	3,657 50
Amherst,	1,844	147	63	2,433 00	2,222 50
Andover,	1,018	69	26	955 00	3,430 00
Arlington,	239	1	1	20 00	5,635 00
Ashburnham,	454	55	16	414 50	752 50
Ashfield,	1,309	54	24	618 72	367 50
Ashby,	538	92	37	1,195 50	367 50
Ashland,	392	27	21	613 00	857 50
Athol,	490	20	7	185 00	2,642 50
Attleborough,	758	46	20	866 00	3,220 00
Avon,	123	4	2	38 00	542 50
Auburn,	785	6	–	–	402 50
Ayer,	135	–	–	–	962 50
Barnstable,	607	5	2	95 00	2,695 00
Barre,	1,882	89	29	843 00	1,032 50
Becket,	634	–	–	–	332 50
Bedford,	594	25	20	615 00	682 50
Belchertown,	1,544	29	7	136 50	630 00
Bellingham,	520	48	28	723 00	490 00
Belmont,	185	–	–	–	2,642 50
Berkley,	381	1	1	10 00	315 00
Berlin,	590	3	3	62 00	350 00
Bernardston,	728	9	1	18 00	297 50
Beverly,	628	4	1	45 00	10,132 50
Billerica,	916	216	103	4,122 00	1,382 50
Blackstone,	339	4	3	62 50	1,890 00
Blandford,	908	4	2	40 00	315 00
Bolton,	819	41	19	537 00	332 50
Boston,	820	119	41	1,388 00	628,740 00
Bourne,	161	–	–	–	1,172 50
Boxborough,	550	16	11	390 00	157 50
Boxford,	617	19	11	352 00	437 50
Boylston,	782	27	12	365 00	350 00
Bradford,	320	–	–	–	1,925 00
Braintree,	399	–	–	–	3,115 00
Brewster,	195	–	–	–	437 50
Bridgewater,	493	40	18	708 00	1,767 50
Brimfield,	1,057	26	18	212 50	297 50
Brockton,	694	12	5	165 00	15,085 00
Brookfield,	731	50	11	370 00	1,050 00
Brookline,	427	5	5	210 00	41,632 50
Buckland,	691	19	4	48 50	420 00
Burlington,	543	11	10	287 50	350 00
Cambridge,	322	1	–	–	54,600 00
Canton,	465	10	3	90 00	3,027 50

CITY OR TOWN.	Neat Cattle Assessed.	Number Tested.	Number Condemned.	Amount Awarded.	State Tax.
Carlisle, ...	630	83	30	$1,239 00	$245 00
Carver, ...	155	–	–	–	577 50
Charlemont, . . .	724	2	–	–	280 00
Charlton, ...	1,603	29	17	447 00	682 50
Chatham, ...	187	–	–	–	665 00
Chelmsford, . . .	1,087	79	51	1,661 50	1,452 50
Chelsea, ...	80	6	1	27 50	15,802 50
Cheshire, ...	960	24	1	30 00	525 00
Chester, ...	637	13	–	–	455 00
Chesterfield, . . .	702	2	2	35 00	210 00
Chicopee, ...	574	1	1	19 00	5,810 00
Chilmark, ...	141	–	–	–	157 50
Clarksburg, . . .	345	–	–	–	175 00
Clinton, ...	170	8	5	170 00	4,865 00
Cohasset, ...	299	–	–	–	3,360 00
Colrain, ...	1,325	20	11	311 45	420 00
Concord, ...	1,419	93	29	786 50	2,940 00
Conway, ...	1,260	97	46	1,433 50	507 50
Cottage City, . . .	120	–	–	–	980 00
Cummington, . . .	593	5	–	–	227 50
Dalton, ...	416	26	6	175 00	2,047 50
Dana, ...	234	–	–	–	210 00
Danvers, ...	774	55	44	1,847 00	3,150 00
Dartmouth, ...	1,642	1	1	10 00	1,890 00
Dedham, ...	1,046	17	12	247 00	4,602 50
Deerfield, ...	1,576	26	9	240 00	1,155 00
Dennis, ...	221	1	–	–	1,172 50
Dighton, ...	367	4	3	52 50	595 00
Douglas, ...	339	8	4	101 00	735 00
Dover, ...	654	30	24	693 00	682 50
Dracut, ...	1,050	77	46	1,318 00	1,172 50
Dudley, ...	852	26	13	309 00	787 50
Dunstable, ...	602	15	7	152 00	210 00
Duxbury, ...	278	12	4	145 00	1,102 50
East Bridgewater, .	529	29	13	261 00	1,155 00
East Longmeadow, .	542	20	10	337 00	490 00
Eastham, ...	156	3	–	–	210 00
Easthampton, . . .	705	10	5	144 00	1,750 00
Easton, ...	589	6	1	15 00	3,552 50
Edgartown, . . .	338	–	–	–	525 00
Egremont, ...	908	3	1	25 00	332 50
Enfield, ...	455	5	–	–	560 00
Erving, ...	152	2	–	–	280 00
Essex, ...	495	–	–	–	700 00
Everett, ...	131	3	1	45 00	8,610 00
Fairhaven, ...	448	–	–	–	1,382 50
Fall River, ...	547	10	4	70 00	43,540 00
Falmouth, ...	424	2	–	–	4,287 50
Fitchburg, ...	770	38	19	555 62	13,860 00
Florida, ...	377	–	–	–	122 50
Foxborough, . . .	383	13	4	75 00	1,190 00
Framingham, . . .	1,148	15	6	167 50	6,527 50
Franklin, ...	667	111	90	3,494 00	2,100 00
Freetown, ...	306	9	4	90 00	630 00
Gardner, ...	543	96	32	1,254 50	3,552 50
Gay Head, ...	55	–	–	–	17 50
Georgetown, . . .	279	–	–	–	752 50
Gill, ...	665	42	13	486 44	332 50
Gloucester, ...	569	–	–	–	11,375 00
Goshen, ...	355	10	2	45 00	105 00
Gosnold, ...	41	–	–	–	140 00
Grafton, ...	1,172	23	10	307 00	1,732 50
Granby, ...	1,130	23	19	427 50	332 50
Granville, ...	774	10	4	120 00	262 50
Great Barrington, .	1,434	15	7	154 00	2,572 50
Greenfield, ...	919	98	53	1,783 20	3,727 50
Greenwich, ...	318	2	1	35 00	192 50

CITY OR TOWN.	Neat Cattle Assessed.	Number Tested.	Number Condemned.	Amount Awarded.	State Tax.
Groton,	925	32	16	$530 00	$2,017 50
Groveland,	222	1	–	–	700 00
Hadley,	1,381	53	17	523 00	735 00
Halifax,	143	–	–	–	192 50
Hamilton,	388	–	–	–	752 50
Hampden,	565	15	2	45 00	280 00
Hancock,	616	3	–	–	245 00
Hanover,	276	1	–	–	1,015 00
Hanson,	151	–	–	–	455 00
Hardwick,	1,714	31	20	601 50	1,085 00
Harvard,	1,272	78	34	1,147 50	717 50
Harwich,	186	2	–	–	875 00
Hatfield,	382	3	1	28 00	735 00
Haverhill,	902	46	19	657 00	14,735 00
Hawley,	583	–	–	–	122 50
Heath,	704	2	1	10 00	140 00
Hingham,	514	–	–	–	3,167 50
Hinsdale,	734	10	2	35 00	542 50
Holbrook,	140	–	–	–	945 00
Holden,	882	6	6	244 00	845 00
Holland,	149	10	3	135 00	70 00
Holliston,	649	7	7	202 00	1,207 50
Holyoke,	477	10	9	320 00	19,040 00
Hopedale,	103	–	–	–	1,820 00
Hopkinton,	801	77	42	1,396 50	1,470 00
Hubbardston,	846	50	31	883 00	490 00
Hudson,	422	25	12	323 50	2,082 50
Hull,	61	5	1	20 00	1,820 00
Huntington,	514	2	–	–	385 00
Hyde Park,	126	–	–	–	5,932 50
Ipswich,	838	33	21	753 00	2,065 00
Kingston,	195	–	–	–	1,172 50
Lakeville,	361	–	–	–	402 50
Lancaster,	638	21	16	505 00	2,082 50
Lanesborough,	940	4	2	35 00	367 50
Lawrence,	198	6	3	140 00	23,240 00
Lee,	741	32	11	373 00	1,295 00
Leicester,	535	3	–	–	1,615 00
Lenox,	729	22	2	75 00	2,082 50
Leominster,	778	40	20	444 00	3,990 00
Leverett,	473	19	15	466 50	210 00
Lexington,	1,013	55	25	761 50	2,852 50
Leyden,	439	3	1	35 00	122 50
Lincoln,	823	104	84	3,625 00	1,610 00
Littleton,	1,265	56	23	904 00	612 50
Longmeadow,	300	9	7	237 00	437 50
Lowell,	331	9	4	90 00	49,000 00
Ludlow,	1,046	33	17	451 50	752 50
Lunenburg,	819	71	47	1,372 50	560 00
Lynn,	307	150	30	1,134 00	34,667 50
Lynnfield,	254	109	56	2,726 00	420 00
Malden,	151	1	1	10 00	17,307 50
Manchester,	95	–	–	–	4,970 00
Mansfield,	219	13	2	30 00	1,277 50
Marblehead,	266	14	2	80 00	4,042 50
Marion,	117	1	–	–	577 50
Marlborough,	998	20	9	180 00	5,792 50
Marshfield,	404	53	26	914 50	945 00
Mashpee,	27	–	–	–	122 50
Mattapoisett,	210	1	1	12 50	1,050 00
Maynard,	312	8	3	95 00	1,470 00
Medfield,	489	2	–	–	997 50
Medford,	294	26	–	–	10,902 50
Medway,	430	8	5	148 00	927 50
Melrose,	224	–	–	–	6,877 50
Mendon,	586	3	1	10 00	385 00
Merrimac,	256	–	–	–	945 00

CITY OR TOWN.	Neat Cattle Assessed	Number Tested.	Number Condemned.	Amount Awarded.	State Tax.
Methuen,	1,345	30	7	$270 00	$2,467 50
Middleborough,	751	1	1	10 00	2,975 00
Middlefield,	470	10	1	20 00	175 00
Middleton,	247	42	41	1,470 00	367 50
Milford,	390	–	–	–	3,867 50
Millbury,	683	32	11	463 00	1,680 00
Millis,	440	8	2	53 00	595 00
Milton,	768	42	9	350 00	13,737 50
Monroe,	153	–	–	–	105 00
Monson,	1,304	21	8	205 00	1,400 00
Montague,	733	31	4	95 00	2,555 00
Monterey,	562	–	–	–	175 00
Montgomery,	339	1	–	–	105 00
Mount Washington,	79	–	–	–	52 50
Nahant,	42	–	–	–	4,042 50
Nantucket,	515	–	–	–	2,117 50
Natick,	587	36	16	479 50	3,990 00
Needham,	690	132	107	3,763 00	1,977 50
New Ashford,	143	–	–	–	52 50
New Bedford,	625	4	2	37 00	36,067 50
New Braintree,	1,240	6	2	30 00	297 50
New Marlborough,	1,607	53	4	119 50	402 50
New Salem,	362	16	5	147 00	227 50
Newbury,	1,116	1	1	30 00	752 50
Newburyport,	289	–	–	–	7,857 50
Newton,	1,100	89	52	1,873 00	32,077 50
Norfolk,	436	48	24	855 50	367 50
North Adams,	617	13	3	90 00	5,477 50
North Andover,	1,277	91	56	2,127 00	2,362 50
North Attleborough,	570	7	7	178 00	2,800 00
North Brookfield,	942	47	14	417 00	1,400 00
North Reading,	364	24	3	132 50	367 50
Northampton,	977	39	5	175 50	7,315 00
Northborough,	768	234	106	3,349 00	892 50
Northbridge,	403	28	11	390 00	2,537 50
Northfield,	1,094	3	3	42 50	682 50
Norton,	336	4	–	–	577 50
Norwell,	272	1	1	18 00	670 00
Norwood,	370	22	10	327 50	2,152 50
Oakham,	686	–	–	–	245 00
Orange,	737	44	29	878 00	2,817 50
Orleans,	212	1	–	–	490 00
Otis,	413	2	1	30 00	157 50
Oxford,	710	19	2	55 00	927 50
Palmer,	707	25	13	345 50	2,030 00
Paxton,	387	2	1	18 00	192 50
Peabody,	687	47	16	634 00	5,477 50
Pelham,	213	2	1	27 00	122 50
Pembroke,	177	3	–	–	472 50
Pepperell,	810	28	15	532 00	1,435 00
Peru,	379	3	1	30 00	87 50
Petersham,	533	6	2	80 00	455 00
Phillipston,	346	–	–	–	210 00
Pittsfield,	1,124	135	19	610 00	9,415 00
Plainfield,	572	8	–	–	122 50
Plymouth,	461	3	2	100 00	4,620 00
Plympton,	108	–	–	–	227 50
Prescott,	387	15	4	95 00	122 50
Princeton,	1,153	139	73	2,231 00	577 50
Provincetown,	54	–	–	–	1,592 50
Quincy,	610	4	2	47 50	11,777 50
Randolph,	202	–	–	–	1,645 00
Raynham,	420	2	–	–	630 00
Reading,	325	17	14	418 00	2,450 00
Rehoboth,	1,265	25	11	332 00	525 00
Revere,	145	–	–	–	4,585 00
Richmond,	468	–	–	–	245 00

CITY OR TOWN.	Neat Cattle Assessed.	Number Tested.	Number Condemned	Amount Awarded.	State Tax.
Rochester,	288	1	–	–	$385 00
Rockland,	232	–	–	–	2,170 00
Rockport,	170	2	–	–	1,845 00
Rowe,	417	1	–	–	175 00
Rowley,	593	99	15	$677 00	490 00
Royalston,	555	81	52	1,832 50	437 50
Russell,	143	5	–	–	350 00
Rutland,	908	65	23	392 50	367 50
Salem,	357	53	31	1,273 00	20,475 00
Salisbury,	469	39	–	–	465 00
Sandisfield,	880	47	18	517 00	245 00
Sandwich,	233	–	–	–	682 50
Saugus,	603	150	35	1,494 00	2,065 00
Savoy,	519	25	4	145 00	122 50
Scituate,	299	2	–	–	1,435 00
Seekonk,	909	26	9	325 00	612 50
Sharon,	362	19	8	240 00	1,137 50
Sheffield,	2,075	15	8	208 50	630 00
Shelburne,	1,214	88	24	796 61	647 50
Sherborn,	760	17	9	196 50	577 50
Shirley,	430	6	3	87 00	525 00
Shrewsbury,	1,277	5	–	–	700 00
Shutesbury,	131	–	–	–	122 50
Somerset,	375	–	–	–	752 50
Somerville,	275	4	1	25 00	30,205 00
South Hadley,	1,074	6	3	65 00	1,645 00
Southampton,	971	1	1	30 00	350 00
Southborough,	1,119	78	24	660 00	1,137 50
Southbridge,	770	58	–	–	2,852 50
Southwick,	833	2	2	30 00	385 00
Spencer,	1,226	5	4	79 50	2,922 50
Springfield,	427	47	18	554 50	41,072 50
Sterling,	1,487	79	50	1,227 00	612 50
Stockbridge,	791	7	3	69 00	2,170 00
Stoneham,	271	9	2	50 00	2,835 00
Stoughton,	337	3	1	15 00	2,117 50
Stow,	840	44	20	656 50	455 00
Sturbridge,	815	6	2	52 50	682 50
Sudbury,	1,245	159	145	5,044 50	822 50
Sunderland,	784	119	20	637 50	297 50
Sutton,	950	128	66	2,202 00	945 00
Swampscott,	70	92	33	1,519 50	3,955 00
Swanzey,	888	–	–	–	612 50
Taunton,	796	8	2	45 00	13,965 00
Templeton,	524	21	10	321 00	980 00
Tewksbury,	546	112	74	2,544 00	1,050 00
Tisbury,	76	–	–	–	577 50
Tolland,	476	4	3	55 00	105 00
Topsfield,	700	52	51	1,902 50	612 50
Townsend,	427	17	8	228 00	840 00
Truro,	221	–	–	–	262 50
Tyngsborough,	378	16	3	77 00	280 00
Tyringham,	409	–	–	–	157 50
Upton,	547	10	6	178 00	735 00
Uxbridge,	710	–	–	–	1,592 50
Wakefield,	293	–	–	–	4,095 00
Wales,	228	–	–	–	210 00
Walpole,	527	28	12	321 00	1,452 50
Waltham,	762	350	227	9,181 00	13,055 00
Ware,	907	11	6	140 00	3,097 50
Wareham,	241	–	–	–	1,470 00
Warren,	1,376	46	24	779 00	1,960 00
Warwick,	274	15	6	170 00	227 50
Washington,	476	–	–	–	140 00
Watertown,	283	28	–	–	5,705 00
Wayland,	870	140	55	1,864 50	1,102 50
Webster,	258	24	17	393 50	2,695 00

CITY OR TOWN.	Neat Cattle Assessed.	Number Tested.	Number Condemned.	Amount Awarded.	State Tax.
Wellesley, ...	287	10	5	$96 50	$4,655 00
Wellfleet, ...	202	–	–	–	542 50
Wendell, ...	191	–	–	–	175 00
Wenham, ...	368	1	1	15 00	472 50
West Boylston, . .	697	14	6	124 00	962 50
West Bridgewater, .	766	6	3	48 00	700 00
West Brookfield, .	943	26	15	449 00	595 00
West Newbury, . .	823	5	1	40 00	700 00
West Springfield, .	656	4	3	125 00	2,887 50
West Stockbridge, .	399	–	–	–	402 50
West Tisbury, . .	238	–	–	–	280 00
Westborough, . .	1,235	114	63	1,702 50	1,960 00
Westfield. . . .	976	3	2	20 00	5,547 50
Westford, . . .	794	17	5	149 00	962 50
Westhampton, . .	469	–	–	–	175 00
Westminster, . .	612	42	32	1,038 50	542 50
Weston, . . .	1,003	102	19	607 50	2,502 50
Westport, . . .	1,175	24	13	310 50	1,102 50
Weymouth, . .	530	2	2	15 00	4,777 50
Whately, . . .	805	27	10	197 00	332 50
Whitman, . . .	333	8	5	81 00	2,555 00
Wilbraham, . .	750	72	21	640 00	595 00
Williamsburg, . .	720	14	5	145 00	665 00
Williamstown, . .	1,362	–	–	–	1,767 50
Wilmington, . .	245	48	40	1,473 86	630 00
Winchendon, . .	498	7	2	50 00	1,645 00
Winchester, . .	198	–	–	–	4,532 50
Windsor, . . .	744	15	12	364 00	140 00
Winthrop, . . .	91	–	–	–	3,045 00
Woburn, . . .	323	12	5	175 00	6,795 00
Worcester, . . .	2,038	38	26	835 50	63,507 50
Worthington, . .	854	43	13	391 00	227 50
Wrentham, . . .	552	22	13	315 00	1,067 50
Yarmouth, . . .	145	1	–	–	1,470 00
Total, . . .	212,601	8,969	{4,144 550	$137,693 55 16,040 25}	$1,750,000 00

List of Towns that have sent in no Returns of Herd Inspections.

Clarksburg,	Halifax,	Nahant,
Essex,	Holbrook,	Oakham,
Florida,	Hyde Park,	Richmond,
Georgetown,	Manchester,	Rockland.
Gloucester,		

The law further provides that all cattle slaughtered upon the premises of the owner, other than a licensed slaughter house, shall be inspected at the time of slaughter, by the inspector, "unless said animal is less than six months old, or has been duly inspected under the provision of this act within six months prior to such slaughter, and a certificate of health has been delivered to the owner or person in charge thereof."

Under this provision the inspectors have reported the following work: —

Number of cattle inspected at time of slaughter, under section 21,	1,964
Number of sheep inspected at time of slaughter, under section 21,	355
Number of swine inspected at time of slaughter, under section 21,	3,050
Number of cattle inspected at licensed slaughter houses at time of slaughter,	102,693
Number of sheep inspected at licensed slaughter houses at time of slaughter,	301,939
Number of swine inspected at licensed slaughter houses at time of slaughter,	773,439
Total number of animals inspected at time of slaughter, including those inspected at licensed slaughter houses and also under section 21,	1,178,071

The following is the return by the inspectors of the number of carcasses condemned as diseased at the inspections at slaughter houses and on private premises: —

Cattle destroyed as tuberculous,	482
Sheep destroyed as tuberculous,	–
Swine destroyed as tuberculous,	91
Percentage of cattle found infected,	.46
Percentage of sheep found infected,	–
Percentage of swine found infected,	.0117

Under the law for the licensing and inspection of slaughter houses the following circular was issued: —

COMMONWEALTH OF MASSACHUSETTS.

BOARD OF CATTLE COMMISSIONERS,
52 VILLAGE STREET, BOSTON, July 1, 1896.

GENTLEMEN: — I beg to call your attention to sections 17, 18 and 22 of chapter 491 of the Acts of 1894, as amended by sections 3, 4 and 8 respectively of chapter 496 of the Acts of 1895, which are in general relation to the licensing of slaughter houses and all similar establishments, the products of which are to be sold or used for food. I will further call your attention to the following paragraph, which is a portion of the said section 18, as amended by the said section 4: "The board or officer of every city or town authorized to issue said licenses shall on or before the first day of June in each year send to the Board of Cattle

Commissioners a copy of every application made to them under section seventeen of this act, and shall state the doings of said board or officer upon said application; and shall further send to the Board of Cattle Commissioners the names and addresses of all persons required to make application under section seventeen, who were engaged in such business on the last day of the previous April, and who failed to make application as provided in said section."

I beg to state further that this Board has not, as yet, received the required notices from you in this connection, and to ask that they be sent without further delay. In answering, kindly give not only the required copy of any "application" that may have been made to you, together with a statement of your doings thereon, but also and particularly "*the names and addresses of all persons in your town required to make application under section 17, and who have failed to make application as provided in said section.*"

An early and full reply is earnestly desired.

Respectfully, CHARLES P. LYMAN, *Secretary.*

The following is the form issued for reports from city and town officials charged with the duty of licensing slaughter houses: —

COMMONWEALTH OF MASSACHUSETTS.

RETURN OF LICENSED SLAUGHTER-HOUSES.

CITY OR TOWN OF MAY, 189 .

To the Board of Cattle Commissioners for the Commonwealth of Massachusetts.

GENTLEMEN: — In accordance with the provisions of section 18 of chapter 491 of the Acts of the year 1894, as amended by section 4 of chapter 496 of the Acts of the year 1895, we submit the following statement in relation to slaughter-houses within the limits of our city or town.

The names of all persons licensed to carry on the business of slaughtering for the following year, a copy of whose application for a license is sent herewith, are as follows: —

NAME.	Address.	License Issued.*	Application Denied.*

* See note on page 544.

The names and address of all persons required to make application, who were in business on the last day of April last past, failing to make application, are as follows: —

Name.	Address.	Licensed Last Year?*	Remarks.

Board or Officer authorized to issue such licenses.

* Note. — Please fill up all blanks as far as possible, stating in each case "yes" or "no" as to whether a license has issued, and as to whether the person was licensed the previous year.

Inspection of Stables.

A large amount of work has been accomplished during the year in the examinations of barns and stables in reference to their sanitary conditions, and the Board is pleased to report that, in response to its advice and suggestions in former reports, there has been quite a marked improvement in this respect. Especial attention has been paid to the relations of manure in cellars, bad ventilation and impure water to the health of animals and the purity of the milk supply.

In accordance with the demands of section 4, chapter 491, Acts of 1894, as amended by section 1, chapter 496, Acts of 1895, the Board sent out the following blank for a return of the inspection and examination of different premises throughout the Commonwealth: —

Report of an Inspection and Examination of the Premises in which the Animals belonging to Mr. of are kept.

[Made in accordance with the demands of section 4 of chapter 491 of the Acts of 1894, as amended by section 1 of chapter 496 of the Acts of 1895.]

Material of building? Length of stable? Width of stable?
Width from mangers or "tie ups" to wall behind animals?
Height from floor to ceiling?
Number of windows facing north? Size of sash?
Number of windows facing east? Size of sash?

Number of windows facing south? Size of sash?
Number of windows facing west? Size of sash?
Is the stable open or closed in front of animals?
Is the stable well lighted?
Is the stable in a basement or cellar?
Is the stable kept clean? What is done with the manure?
Is there a cellar under barn?
Is the cellar open or closed?
Does the air in the stable seem good, or is it heavy or bad smelling?
Is the stable warm or cold? How is the stock watered?
If from well, give its location in regard to barn cellar, manure yard or any other source of possible contamination?
Is soil under building dry, or wet?
Is it gravel, sand, clay, or rock?
Are animals in a thrifty or unthrifty condition?
Is the stock kept well cleaned?

189 .

Inspector.

From the returns of the above inspection, sent to this office, the following tables have been compiled: —

Total number of stables inspected,	24,161
of stables on the ground,	9,358
of stables over cellars,	12,594
of stables in cellars,	2,209
of stables with good light,	15,371
of stables with bad light,	6,590
of stables with no light,	2,200
of stables with good ventilation,	19,981
of stables with bad ventilation,	3,217
of stables with no ventilation,	963
of stables with good water supply,	9,083
of stables with fair water supply,	12,511
of stables with bad water supply,	2,567

Taking all these details into consideration, we classify the barns and stables inspected as follows: —

	Per Cent.
In good condition,	56
In fair condition,	36
In bad condition,	8

List of Towns that have sent in no Returns of Inspection of Stables.

Amesbury,	Greenwich,	North Attleborough,
Brookline,	Halifax,	North Reading,
Bradford,	Heath,	Northbridge,
Billerica,	Holbrook,	Oakham,
Burlington,	Holden,	Pittsfield,
Clarksburg,	Hyde Park,	Provincetown,
Colrain,	Holyoke,	Richmond,
Conway,	Hampden,	Rockland,
Dedham,	Leverett,	Russell,
Dover,	Lincoln,	Rutland,
Danvers,	Littleton,	Sandisfield,
East Longmeadow,	Manchester,	Sheffield,,
East Bridgewater,	Marlborough,	South Hadley,
Erving,	Marshfield,	Sherborn,
Essex,	Montville,	Springfield,
Florida,	Natick,	Wareham,
Framingham,	Needham,	Ware,
Freetown,	New Ashford,	Wellesley,
Gardner,	New Salem,	Winthrop,
Georgetown,	Newbury,	Wilmington,
Gloucester,	Newton,	Woburn.
Gosnold,	Norfolk,	
Greenfield,	North Adams,	

The laboratory work, in connection with reports on hygienic conditions of barns, has been conducted similarly to last year, with a few important exceptions, which it may be well to note.

The carbonic acid determination was made a year ago, by means of the apparatus devised by Professor Fitz of the Lawrence Scientific School for testing air of school-rooms, and, while of course not absolutely correct, yet approximate results were easily obtained, comparable with one another and accurate enough for all purposes of our investigation. This has been omitted in this year's work, as, to obtain satisfactory results, it was necessary for an agent of the Board to spend a night in the town, and visit the barns by the time they were first opened in the morning. This limited the examinations which one man could make to about two per day, and entailed comparatively heavy travelling expenses. This year, also, a part of the investigation has been left to the local inspectors, so that one agent can visit two or three towns and make six or eight examinations per day.

The estimation of bacteria in the air has likewise been left out of this report, partly for reasons similar to those just given under the carbonic-acid determination, and more particularly because the results were not satisfactory, and in many cases we believe not reliable, as obtained by our method of 1895.

During the year reports have been sent to the Board, from various inspectors, as to the sanitary conditions existing in some places, which seemed to call for special investigation. All such reports are looked into as soon as possible, and, if found to be well grounded, the local boards of health are notified, after which no further action has been taken, as the intention is not to interfere in any way with any person or public board, but simply to improve to a great extent conditions which are recognized as dangerous not only to the individuals using the impure water, but in some cases to the entire community, as was case No. II., for the month of October, 1895.

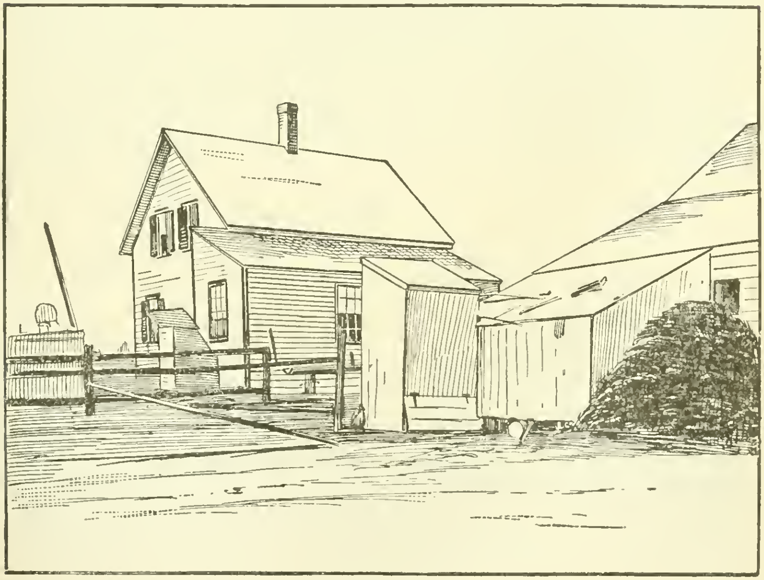

Figure No. 1.

This case is illustrated (Figure 1) where we see the well at the end of the house (between two lower windows); the

privy between well and barn, and a large manure heap on the extreme right, which has been thrown from the little

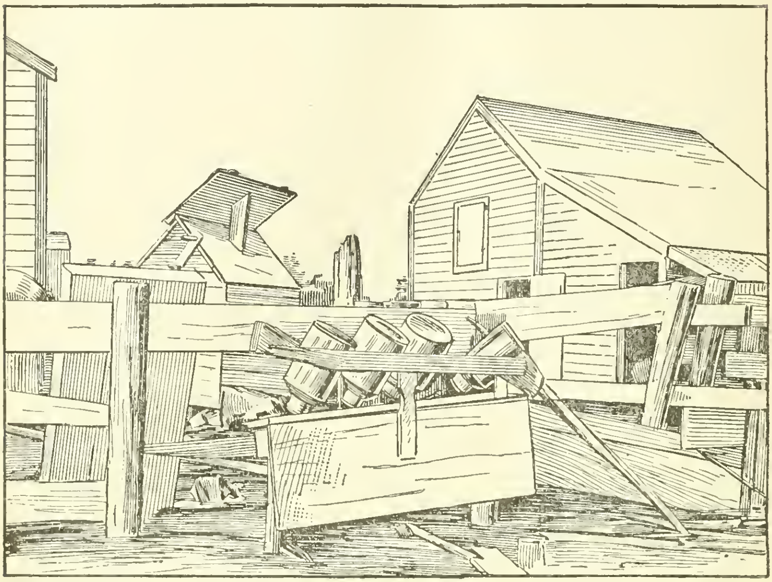

FIGURE No. 2.

square window appearing just above it in the side of the barn. An additional source of contamination, which the picture

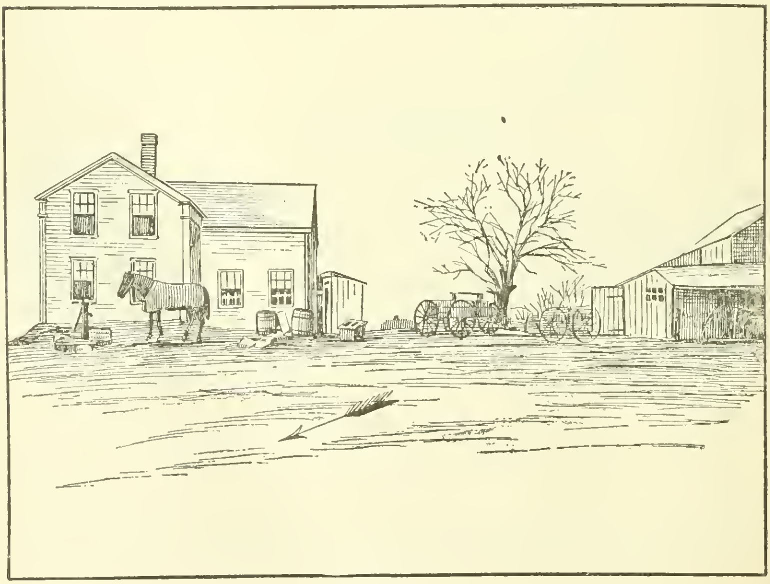

FIGURE No. 3.

does not show, is a sink drain, which runs out on top of the ground just under the back window. From the well to the manure heap is perhaps forty feet.

Figure 2 shows the same house (on the left), the barn (on the right), and a view of the well with the milk cans draining behind it. The water from the well was found upon analysis to be contaminated by a very large amount of organic impurity, the very high chlorine showing it to be of animal origin.

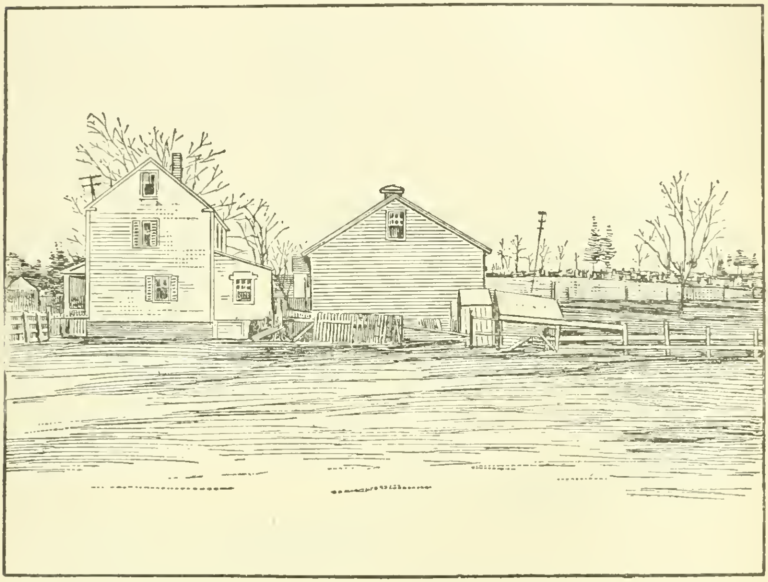

FIGURE No. 4.

Figure No. 3 is of a well (directly before the horse) which received the drainage of such buildings as the picture shows, also a very filthy pig pen, concealed by the door of the shed. The owner claims that a ledge runs a few feet under the surface, in the direction of the arrow. This is probably true, and the conditions give but very slight opportunity for filtration and consequent oxidation of sewage before it reaches the well.

Figure 4 is another of the cases to which the attention of the Board has been called by the local inspector. The barn, forty by forty feet, is all open inside. No particular place

for animals, — one horse, three cows, two calves and thirty-eight hogs have a picnic together. Situated on land under water five months in the year. Sickness in the family with typhoid fever existed during the year.

The well is a few rods distant on the other side of the barn, and an analysis of the water, while showing contamination, is far better than would at first be supposed. This is due to the character of the soil through which the water runs.

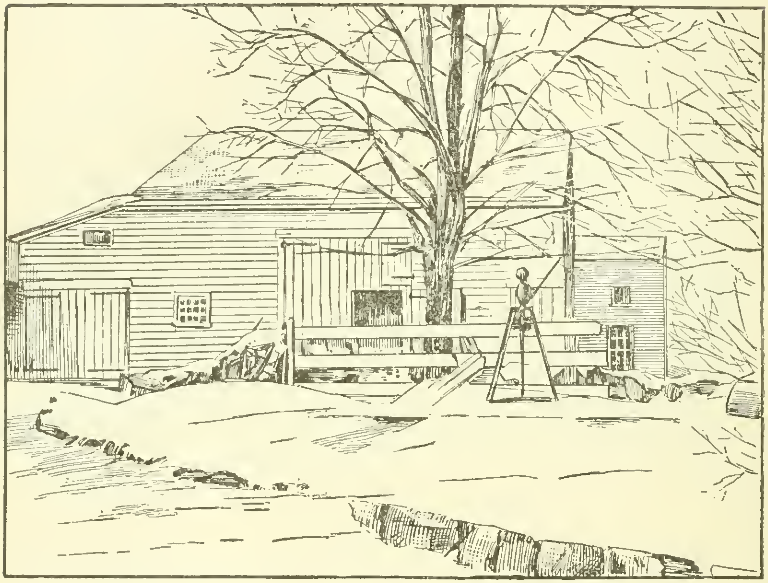

FIGURE NO. 5.

Figure No. 5 shows another case in which the water was found to be badly contaminated. The well (under tree in foreground) is so situated that it receives the drainage from the barn, which contains fourteen cattle. The water is obtained from a pump in the barn behind the horse stall, the pipe from which runs through the manure heap in the barn cellar. This water comes from the well shown in the picture, and contamination is present in a marked degree, as shown by chemical analysis.

Summary of Laboratory Reports on Hygienic Conditions of Barns inspected during November and December, 1896.

No.	TOWN.	Date (1896.)	Number of Animals.	Cubic Feet of Air Space per Head.	Condition of Ventilation.	Condition of Water.
1	Waltham, . .	Nov. 12	7	2,000	Fair,	Contaminated.
2	Waltham, . .	" 12	14	860	Poor,	Very bad.
3	West Bedford, .	" 24	9	1,600	Fair,	Slight contamination.
4	Bedford, . .	" 24	18	1,500	Good,	Good.
5	Sudbury, . .	" 25	22	980	Fair,	Slight contamination.
1	Norwood, . .	Dec. 1	–	–	Fair,	Contaminated but well filtered.
2	Lexington, .	" 2	19	2,500	Good,	Contaminated.
3	Watertown, .	" 8	14	1,500	Good,	Slight contamination.
4	Watertown, .	" 8	13	620	Fair,	Fair.
5	Watertown, .	" 8	3	330	Fair,	Slight contamination.
6	Watertown, .	" 8	37	800	Good,	Fair.
7	Rowley, . .	" 9	4	770	Fair,	Slight contamination.
8	Rowley, . .	" 9	8	1,600	Fair,	Fair.
9	Rowley, . .	" 9	3	2,500	Fair,	Fair.
10	Rowley, . .	" 9	12	750	Poor,	Very bad.
11	Rowley, . .	" 9	12	1,200	Good,	Good.
12	Rowley, . .	" 9	12	800	Fair,	Good.
13	Newburyport, .	" 9	44*	540	Fair,	Slight contamination.
14	Newburyport, .	" 9	2	–	Fair,	Dangerous.
15	North Billerica,	" 11	20	1,000	Fair,	Slight contamination.
16	Billerica, . .	" 11	17	2,200	Fair,	Fair.
17	Billerica, . .	" 11	15	800	Fair,	Slight contamination.
18	Billerica, . .	" 11	8	1,600	Fair,	Bad.
19	Billerica, . .	" 11	27	700	Good,	Good.
20	East Billerica, .	" 11	5	1,000	Poor,	Fair.

The figures given for some of the barns in Billerica are estimates made by the agent, as the inspector's returns were not made in season for use in this report.

Work at the Public Markets.

The work of the Board at the public cattle markets at Brighton, Watertown and Somerville has been constant during the year, and has occupied much of the time of one of its members. The work has included the identification

* Thirty-eight hogs.

and release of animals from without the State, that came in with certificates of soundness from approved veterinarians or that came in for immediate slaughter, and the testing of such cattle as are brought from without the State without certificates.

Besides this, the reception and slaughter and post-mortems upon cattle sent from all over the State by local inspectors, after condemnation by the Board, has consumed much time and careful attention. It has been found advisable to have nearly all this work done at Brighton, rather than to send an agent to each farm where diseased cattle are found, kill them and pay for their proper burial.

Under the present system all the work is superintended by a member of the Board, and the carcasses bring a considerable revenue from the rendering establishment. During the year this method has proved sufficient to pay all expenses incident to shipping, driving and slaughtering the cattle, cleaning and disinfecting the cars, etc., and have a balance of $2,783.36, which has been turned into the State treasury. A larger advantage is the fact that the Board is certain as to the disposal of the infected carcasses. The number of such cars arriving at Brighton during the year is 144, and at Watertown 83.

The work of cleaning and disinfecting these cars has absorbed considerable time. A small boiler and steam pump are used, and the disinfectant is heated and thrown into each car with a jet of live steam, thus reaching every part, and removing any germs that may be present.

Animals coming without certificates have been held in quarantine for at least six days, and then subjected to the tuberculin test. The holding of these animals for at least six days before testing, to allow of their return to a normal condition after the fever-inciting experiences of travel, has proved that the unfortunate experiences with the tuberculin test at these markets earlier in the work of this Board were almost wholly due to the application of the test immediately after the arrival of the animals. Under the longer quarantine before test the results have been quite satisfactory.

Under the arrangement entered into with the Cattle Commissioners of the adjoining States, nearly all the cattle sent from without the State to the public markets at Brighton,

Watertown and Somerville have been tested by approved veterinarians before entering the State. However, 501 animals have appeared at these markets without certificates of test. Of these, 18 were found diseased with tuberculosis, and were destroyed, and 5 others were condemned as affected with actinomycosis.

The details of the work at the several markets are as follows: —

Report of Stock received at Brighton from Dec. 15, 1895, to Dec. 15, 1896.

Maine cattle,	7,951
New Hampshire cattle,	2,639
New York cattle,	448
Massachusetts cattle,	6,900
Western beef,	18,879
Sheep,	74,449
Calves,	18,510
Hogs,	43,068
Cattle released on certificates,	7,781
Cattle tested,	200
Cattle released after test,	197
Cattle condemned after test,	3
Cattle retested at abattoir,	395
Cattle condemned at abattoir after retest,	395

Report of Stock received at Watertown from Dec. 15, 1895, to Dec. 15, 1896.

Vermont and New Hampshire cattle,	7,487
Massachusetts cattle,	1,793
New York cattle,	675
Western beef,	139,285
Northern beef,	5,354
Sheep,	357,899
Calves,	47,079
Hogs,	1,340,939
Cattle released on certificates,	8,162
Cattle tested,	211
Cattle released after test,	199
Cattle condemned after test,	12

Report of Stock received at Somerville from Dec. 15, 1895, to Dec. 15, 1896.

Western beef,	49,455
Vermont and New Hampshire cattle,	436
Massachusetts cattle,	257
Sheep,	413,876

Calves,	49,671
Hogs,	12,904
Cattle released on certificates,	436
Cattle tested,	90
Cattle tested and released,	87
Cattle tested and condemned,	3
Cattle condemned, actinomycosis,	5

Recapitulation.

Total amount received at the three stations: —

Total number of cattle,	241,559
Total number of sheep,	846,224
Total number of calves,	115,260
Total number of hogs,	1,396,911
Total number released on certificates,	16,379
Total number tested at stations,	501
Total number released at stations,	483
Total number condemned at stations,	18
Total number condemned for actinomycosis,	5

Aside from the stock brought into the State on veterinarians' certificates for the purpose of sale at the public markets, permits were issued to parties desiring to import animals to replenish their own stables, or to return animals owned here but pastured without the State during the season. The amount of this work has been as follows: —

Report of the Number of Cattle brought into the State on Permits, from Dec. 15, 1895, to Dec. 15, 1896.

Dec. 15 to 31, 1895,	390
January, 1896,	532
February, 1896,	302
March, 1896,	359
April, 1896,	343
May, 1896,	203
June, 1896,	411
July, 1896,	407
August, 1896,	411
September, 1896,	825
October, 1896,	945
November, 1896,	1,681
December 15, 1896,	409
Total,	7,218

The total number of permits for these cattle was 569.

Glanders.

During the past year the Board has had 384 horses reported as suspected of being affected with glanders. The cases reported and their location are as follows: —

Town.	Number of Animals.	Town.	Number of Animals.
Arlington,	1	New Bedford,	4
Beverly,	1	Newton,	5
Billerica,	1	Northampton,	2
Blandford,	1	North Andover,	1
Boston,	108	Northborough,	1
Brockton,	1	North Brookfield,	1
Cambridge,	13	Quincy,	3
Charlestown,	15	Rowe,	1
Chelsea,	4	Randolph,	1
Clinton,	1	Salem,	1
Cohasset,	1	Sandisfield,	1
Dartmouth,	1	Saugus,	2
Dedham,	5	Scituate,	1
Easton,	2	Somerville,	9
Everett,	2	Southampton,	1
Fall River,	21	Southborough,	1
Framingham,	1	Springfield,	4
Grafton,	2	Stoneham,	3
Greenfield,	1	Taunton,	4
Hardwick,	1	Upton,	1
Holyoke,	3	Waltham,	1
Hyde Park,	2	Watertown,	1
Leicester,	1	Webster,	1
Lexington,	2	Wellesley,	1
Longmeadow,	1	Wenham,	2
Lowell,	2	Westborough,	1
Lunenburg,	1	Westfield,	7
Lynn,	3	Westford,	1
Malden,	6	West Springfield,	1
Marlborough,	1	Winchester,	1
Medford,	1	Worcester,	100
Millbury,	1	Wrentham,	1
Milford,	2	Yarmouth,	1
Needham,	5	Not given,	4

Of this number, 341 were either condemned as diseased, or killed at the request of the owner.

The statistics show an increase in the disease in the State the past year; but this fact is probably practically due to a better understanding of the law relating to it rather than to any absolute increase in the number of cases. Formerly many cases were handled by veterinarians or by owners, and killed without any report being made. As the public has become aware of the requirement of the statute, that all such cases must be reported to this Board, the list of cases has steadily increased.

In the opinion of the Board, it is quite practicable to largely reduce the prevalence of this disease, as local inspectors and boards of health become better acquainted with their duties, and come to a full appreciation of the importance of active observance of the law in regard to the reporting of cases. Much can also be done to restrict the disease, if reasonable precautions are observed by owners. The watering of horses at public troughs, the hitching to public posts and stabling in places of doubtful safety are all ready means for transmitting infection.

Rabies.

On or about Dec. 10, 1895, there were reports of the appearance of several dogs apparently affected with rabies in the vicinity of Boston. Careful investigation was made of the reported cases, and, it appearing that there was reason to fear an extension of the trouble unless prompt measures were taken, the Board issued the following order of quarantine: —

COMMONWEALTH OF MASSACHUSETTS.

Board of Cattle Commissioners,
52 Village Street, Boston, Jan. 23, 1896.

To the Cities and Towns of Newton, Cambridge, Watertown, Belmont, Somerville, Arlington, Medford, Malden, Everett, Chelsea and Revere, the Boards of Health within the Same and All Persons whom it may concern: —

Whereas, Rabies, a contagious disease under section 37 of chapter 491 of the Acts of the year 1894, has appeared among certain domestic animals, to wit, dogs, in certain portions of this Commonwealth; and

Whereas, The Board of Cattle Commissioners of said Commonwealth is authorized, under the provisions of sections 38, 39 and 40 of said chapter 491, to make orders and regulations concerning the extirpation, prevention and suppression of contagious diseases among domestic animals; and

Whereas, The Board of Cattle Commissioners is of the opinion that there is danger of the further extension of said disease, and that the public exigency requires that steps be taken to prevent the further spread of said disease and to suppress the same as far as possible;

Now, therefore, we, the Board of Cattle Commissioners for the Commonwealth of Massachusetts, by virtue of the power and authority in us vested by law, have adopted and do hereby issue the following order: —

General Order No. 11.

First. — The cities and towns of Newton, Cambridge, Watertown, Belmont, Somerville, Arlington, Medford, Malden, Everett, Chelsea and Revere are hereby declared to be infected districts and are hereby made subject to the regulations hereinafter imposed.

Second. — No dog shall be permitted to go at large within the limits of any of said cities or towns unless such dog is securely muzzled with a properly fitting wire muzzle. All said dogs shall remain so muzzled for a period of ninety days from Jan. 23, 1896.

Third. — The boards of health of the cities and towns herein named are hereby ordered and directed to see that this order is strictly complied with within the limits of their respective cities and towns, and they are hereby directed to cause every dog found at large, contrary to the orders herein contained, to be seized and securely confined in some suitable place to be by them selected, and not to permit said animal to go at large thereafter, except in compliance with this order. Each of said boards is further ordered to safely quarantine all animals within the limits of their city or town suspected of being affected with rabies, and to immediately report the same to this Board, in accordance with said chapter 491.

Fourth. — No person within the limits of said cities or towns shall, during the continuance of this order, permit any dog owned by him, or which is within his possession or control, to go at large within the limits of any of said cities or towns, unless said dog is at all times securely muzzled as hereinbefore provided. The leading of dogs through the streets by a leash or chain, unless so properly muzzled, is hereby forbidden.

Fifth. — Every person who has knowledge of or has reason to suspect that any dog within any of said cities or towns is affected with or has been bitten by an animal affected with rabies, whether this knowledge is obtained by personal examination or otherwise, shall immediately give notice of the fact to the Board of Health of the city or town where such dog is kept.

Sixth. — Each city and town herein mentioned shall cause a copy of this order to be published once at least in a daily newspaper published in said city or town. If no such paper is so published, then by posting a copy of this order in two or more public places within the limits of said city or town.

Seventh. — This order shall take effect upon the twenty-third day of January, 1896.

FREDERICK H. OSGOOD, *Chairman,*
CHARLES P. LYMAN, *Secretary,*
MAURICE O'CONNELL,
LEANDER F. HERRICK,
CHARLES A. DENNEN,
Board of Cattle Commissioners.

This action was criticised as arbitrary and unnecessary by a portion of the community affected, but the result justified the action, for, while isolated cases, fairly traceable to those first reported, did appear, the public was on its guard, and no generally serious consequences followed.

The following is the full list of cases reported to the Board during the year: —

DATE.	Town.	Number of Cases.
January 6,	Waltham,	1
January 21,	Revere,	1
February 21,	Hardwick,	1
February 29,	Chelsea,	1
March 1,	Haverhill,	1
March 14,	Lowell,	1
March 18,	Salem,	1
April 1,	Boston,	1
April 14,	Haverhill,	1
May 16,	Cambridge,	1
June 12,	Lynnfield,	1
July 23,	Cambridge,	1
November 9,	South Hadley,	1
November 27,	South Hadley,	1
December 3,	Haverhill,	1
December 18,	Boston,	1
Total,		16

Hog Cholera.

While this State has been comparatively free from hog cholera and swine plague, diseases which resemble each other so closely that only post-mortem examination and the use of the microscope can be relied upon with certainty to determine their individual character, — they are in other sections of this country the cause of the loss of millions of dollars every year to the farmers.

The Bureau of Animal Industry, in charge of Dr. D. E. Salmon, at Washington, has issued important bulletins, in which it is stated that the symptoms of the two diseases and their effect are quite similar, and that both are caused by bacteria. They must, therefore, be met by preventing the infection of the premises, the destruction of the germs wherever they have found lodgement, the treatment of the sick animals to reduce the fever, stopping the propagation of the germs, and the careful disposition of the bodies of the animals dying from the disease. The treatment of the two diseases is essentially the same.

Young animals are especially susceptible to the diseases, the older ones seeming to have a greater power of resisting infection. It is also believed that animals once slightly affected, and recovered, are, to a large extent, immuned from subsequent infection, while fresh animals placed in the same pens are infected by the germs remaining from the original cases. The germs are tenacious of life, and infection may result from their presence in food or drink, or in the air. After infection the disease develops in from four to twenty days. In acute cases animals die suddenly, often before their illness has been observed, but more often there is a longer period in which to observe the progress of the disease.

The usual symptoms are fever, shivering, torpidity, loss of appetite, a temperature rising to 106° or 107° F., exhausting diarrhœa, an exudation of a thick secretion from the eyes, quick, labored breathing, cough, a redness of the skin, a crusty eruption, and loss of strength and of flesh until the end.

The indications of hog cholera by post-mortem examination are : —

1. Hemorrhages, particularly in the subcutaneous, submucous and subserous connective tissues; in the lymphatic glands and in the various organs of the body.

2. Ulcerations of the large intestines.

3. Collapse of lung tissue, and less frequently bronchopneumonia.

The most characteristic lesions of swine plague are: —

1. Inflammation of the lungs; numerous small necrotic points in these organs, or a few large cheesy masses.

2. Inflammation of the serous membranes, with fibrinous deposits.

3. Congestion of the mucous membrane of the intestine, or inflammation of the same, with fibrinous deposits.

Experts do not yet agree as to the certainty of remedies, but Dr. Salmon says: —

The most efficacious formula which has been tried is the following: —

	Pounds.
Wood charcoal,	1
Sulphur,	1
Sodium chloride,	2
Sodium bicarbonate,	2
Sodium hyposulphite,	2
Sodium sulphate,	1
Antimony sulphide (black antimony),	1

These ingredients should be completely pulverized and thoroughly mixed. The dose is a large tablespoonful for each two hundred pounds weight of hogs to be treated, and it should be given only once a day. They should have at least once a day soft feed, made of mixed bran and middlings, or middlings and corn meal, or ground oats and corn, or crushed wheat with hot water, and then stirring into this the proper quantity of medicine. Animals that will not come to the feed should be drenched with the medicine shaken up with water. Great care should be exercised in drenching hogs, or they will be suffocated. Do not turn the hog on its back to drench it, but pull the cheek away from the teeth so as to form a pouch, into which the medicine may be slowly poured. It will flow from the cheek into the mouth, and when the hog finds out what it is, it will stop squealing and swallow.

This medicine may also be used as a preventive of these diseases, and for this purpose should be put in the feed of the whole herd. Care should of course be observed to see that each animal receives its proper share. The animals should be kept dry and comfortable, and where draughts of air will not blow upon them. The food must be such as can be digested by the irritated and inflamed organs.

When the hogs are first found to be affected, the lot or the pens should be disinfected by dusting plentifully with dry, air-slaked lime, or by sprinkling with a five per cent. solution of crude carbolic acid. The animals should then be all removed to new quarters. If possible, the sick and apparently well should be separated before they are moved, and then put into different lots. The hogs should be kept in dry lots or pens, where there is no mud, and, above all, no stagnant water. It is well to keep these lots disinfected by the free use of air-slaked lime or carbolic acid.

If any hogs die during the progress of the outbreak, their carcasses should be immediately burned or deeply buried, and the places where they have lain, or the ground over which they are dragged, should be disinfected with carbolic acid or lime, according to the method already mentioned.

When these diseases appear upon a neighboring farm, precautions should be adopted to prevent the introduction of the contagion. No one should go upon the fields or into the pens where the sick animals are, and then go into another farm where the disease has not appeared. Remember that a particle of manure or dirt the size of a mustard-seed from an infected farm is sufficient to start an outbreak that will destroy a herd of swine. A particle of that size may be carried upon the shoes of a visitor, upon the foot of a dog or other animal, upon a wagon wheel or in a multitude of other ways. Non-intercourse at such times is, therefore, the safest rule. It is advisable, when there is reason to fear this disease, to keep the hogs in a small enclosure, which should be as dry as possible, and disinfected once a week with air-slaked lime or a five per cent. solution of carbolic acid. A small quantity of carbolic acid (three to fifteen drops, according to age) in the drinking water tends to prevent infection, and may have a beneficial influence upon the course of the disease.

Hog cholera has been reported to the Board during the year as follows: —

TOWN.	Number of Cases.	Number of Animals.
Adams,	1	13
Billerica,	1	24
Dalton,	2	8
Hanover,	1	1
Holyoke,	2	24
Ludlow,	2	12
Merrimac,	1	3
Plymouth,	1	1
Sherborn,	1	2
Westfield,	3	6
Westminster,	1	1
Total,	16	95

Laboratory Report.

The following is a report of the work in the laboratory of the Board during the year: —

To the Board of Cattle Commissioners, Boston, Mass.

Gentlemen: — We herewith submit a report of the work done in the laboratory under the direction of the Board for the year 1896. It has consisted of the examination of specimens, which have been sent by inspectors and others, of doubtful cases of disease, where a careful and microscopic examination was needed; of experimental work and of the chemical analysis of water and sanitary inspection of premises.

There have been about two hundred specimens examined, which are classified in Table I.

Tuberculosis shows the largest number, as the work has been mainly directed to that during the year. The most interesting cases were those where a very minute lesion was found in cattle that had given a high reaction, and emphasizes the necessity of a thorough examination of every gland before placing the case among those in which the test failed. This confirms the experience of last year.

Swine are the next greatest sufferers from the disease; while the samples from sheep, hens or dogs have not shown any positive evidences, and, although its existence among these animals is not denied, its spontaneous occurrence must be regarded as a great

rarity in this State. On account of the tendency to early calcification of the chessy masses, the bacilli are found with great difficulty, and in all doubtful cases inoculation was resorted to as a means of diagnosis.

Experiments were tried to inoculate hens with tuberculous material from both cattle and swine, but there was not the slightest evidence of infection after many months. This is in accordance with the observation of others, and is a strong argument in favor of regarding the bacillus of avian tuberculosis as certainly a variety, if not a distinct species, from that of the mammalian. Its manner of growth in pure culture also confirms this view. Its casual relation, therefore, to human tuberculosis, must still be regarded as under judgment.

Experiments in the inoculation of calves with human tuberculous sputa were carried out by Dr. Langdon Frothingham, who makes a special report on this work.

The conditions which are the most frequently confounded with tuberculosis are those due to actinomycosis, œsophagostoma and fatty infiltration of the liver.

Actinomycosis (lump jaw), a new growth due to a polymorphous bacillus, is usually situated on the ramus of the lower jaw, but occasionally attacks other parts of the head and the lungs. The tissue to the eye appears of the uniform pale-grayish color, usually dotted with small holes, from which pus can be squeezed, containing small yellowish granules (masses of the bacilli, actinomyces). When abscesses are formed in the lung, the pus is very tenacious and stringy, looking more like very thick mucus, and has in it the same little bodies.

Œsophagostoma Columbianum, a small round worm, produces a nodular disease of the intestine in sheep and cattle. The little tumors, which may be mistaken for tubercles, are situated in the wall of the intestine, sometimes projecting into the gut and at other times more prominent on the outside. They are gritty, and when cut open are found to contain a dry, greenish material, which at once distinguishes them from the products of the tubercle bacillus, which are yellow, cheesy and calcified.

Fatty Infiltration of the Liver. — Often a small area of the liver stands out in striking contrast to the dark-brown color of the rest of the organ, by its opaque color. This is due to a local infiltration of the liver cells with fat. From early tuberculosis it is distinguished by the sharp outline against the neighboring tissue and by the absence of any evidence of inflammatory action, in the way of increased redness, about it, or of any tendency to calcification.

Experiments were carried on last year with Klebs' antiphthisin

as a curative agent, with negative results. Tests are now being made with aseptolin (Edson), protonuclein, both hypodermically administered; and guiacol carbonate, given internally; but as yet it is too early to give the results.

Glanders. — As an aid to diagnosis in doubtful cases, the inoculation of guinea pigs has been made. The discharge from a suspicious ulceration was collected on a swab of absorbent cotton, and this was then carefully washed out in a little distilled water and injected into the peritoneal cavity with a subcutaneous syringe. If the bacilli of the disease were present, an inflammation of the peritoneum was set up, characterized by the presence of small granulations on the surface, with fibrinous exudation. This readily extended to the tunica vaginalis in the males, causing a marked swelling in the region of the testicle that could be readily recognized externally. The process required from three to six days for its development.

As can be readily understood, the bacilli may be absent in the discharge, and therefore a negative result cannot be absolutely relied upon to exclude the disease. But it is a distinct aid in doubtful cases, and should always be employed. Six cases were examined; in two it gave a positive result, in three a negative one, confirming the diagnosis, and in one it was at fault, as the case was a clear one from the clinical side.

Rabies. — The existence of an epizootic of this disease was confirmed by the results of inoculations. As is well known, there are no changes in the body by which the existence of this disease can be absolutely shown, and, although the presence of foreign material (straw, hair, bits of wood, etc.) in the otherwise empty intestine of a dog that has acted strangely, or furiously, is strongly presumptive evidence, still it can only be surely established by the transmission of the disease to some other animal. This was done upon rabbits, after Pasteur's method.

Twenty-five suspected animals have been received during the past year for examination: of these, thirteen gave a positive result; of the remaining twelve, one was too much decomposed to be used, two showed evidence of other disease (broncho-pneumonia, menigitis), from two the rabbits died from sepsis, four gave clearly a negative result and three are still under observation. The time of incubation in the positive cases varied from six to ninety-one days. The larger number showed symptoms between the fourteenth and eighteenth day. The details are given in Table II.

From these observations, which are in accord with those the the world over, a given case cannot be declared negative until at least after three months have elapsed from the time of inoculation. If any means can be devised by which a certain diagnosis can be

arrived at in a short time, it will be a great step in advance. Keirle ("New York Medical Journal," Vol. 60, page 27) has suggested the use of mice for this purpose, claiming, from the results of his experiments, that a few drops of fluid, in which was suspended a little of the brain of a rabid animal, inoculated at the root of the tail, produced the disease in from seven to eleven days. Upon study of his work it was found that he had only used material coming from experimental animals, in which the virus was tolerably constant. It was deemed advisable, therefore, to try it in the ordinary cases of street rabies, as they came to the laboratory. In this work I was kindly assisted by Dr. Langdon Frothingham. The results of our work can be briefly stated as follows: —

As a rule, the mice died more quickly than the rabbits, but there were marked exceptions to this. The symptoms were by no means as clear, and were often only of a few hours' duration before death. When this is taken into account, with the liabilty of such quick-moving little animals to escape, and the difficulty of identification, they were found to be practically of no advantage over rabbits.

Another series of experiments had in view the isolation of the virus. It has never been clearly shown what this is, and, although there are many reasons which render it probable that it depends upon the action of the bacteria, still, none have ever been shown that can reproduce the disease. It has, therefore, suggested itself that the poison may be of the nature of a chemical ferment; and an attempt was made to obtain this by means which should exclude the possible action of bacteria.

The brains of two rabbits which had died from rabies were divided into four equal parts and allowed to macerate for about four days in a cold place, as follows: No. I., in ether; No. II., in a mixture of ether 65, alcohol 15 and chloroform 20 parts; No. III., in benzole; No. IV., in rhigolene. These extracts were then passed through a Pasteur filter, to remove any bacteria that might have been in the original brain substance; the ethereal and other solvents were removed by careful evaporation in vacuo at a low temperature, and towards the end of the process a little sterilized water was added, to prevent complete desiccation, which it is well known destroys the virus. From each of the four extracts a considerable residue was thus obtained. Distilled water to the amount of about 10 cubic centimeters was added to each, and the substance, as finely divided as possible by breaking up with a glass rod, was suspended in it.

Two rabbits were inoculated in the usual way from each of the three mixtures, with the following results: No. I. A rabbit dies

at the end of the seventh week, with illy defined symptoms of paralytic rabies. The result of an inoculation from this rabbit is doubtful. No. II. One rabbit died at the end of six and a half and the other at seven weeks, with symptoms similar to paralytic rabies. The rabbits inoculated from these have shown no symptoms. No. III. Gave a negative result. No. IV. One rabbit died after four and one-half weeks. Second inoculation negative.

These experiments are too few and imperfect, as yet, to be of value beyond indicating a line upon which experiments may be conducted during the coming year, but the work will necessarily be very slow, as from two to three months is required to complete a single series, and a most careful control will have to be exercised to guard against possible sources of error.

TABLE I. — *Specimens Examined.*

Cattle: —		Dogs: —	
Abscess,	13	Meningitis,	1
Actinomysis,	3	Pneumonia,	2
Atalectasis,	1	Poison,	1
Bronchitis,	4	Rabies,	12
Calculus,	1	Doubtful,	7
Cancer,	1		
Emphysema,	1		23
Fatty infiltrated liver,	3		
Œsophagostoma,	2	Swine: —	
Pneumonia,	5	Bronchitis,	1
Tuberculosis,	87	Emphysema,	2
	111	Fatty infiltrated liver,	1
Cats: —		Gangrene,	1
Enteritis,	1	Hog cholera,	2
Rabies,	1	Pneumonia,	3
		Tuberculosis,	10
	2		
Horses: —			20
Azoturia,	1		
Glanders,	6	Hens: —	
Pericarditis,	1	Filbroma,	1
Pneumonia,	1	Aborted eggs,	1
Rabies,	1	Pneumonia,	1
Osteo-sarcoma,	1	Doubtful,	1
	11		
Sheep: —			4
Œsophagostoma,	2		
Pneumonia,	1	Normal organs,	22
Filaria,	2	Decomposed,	8
	5		

Total examinations, ... 206

TABLE II. — *Inoculation for Rabies.*

DESCRIPTION OF ANIMALS.	Town.	Inoculated.	Rabies, First Symptom.	Days Elapsed.
		1896.	1896.	
C. C. 432, Newfoundland dog, (*a*) .	Waltham, . .	Jan. 6,	Jan. 20,	14
455, poodle, ...	Revere, . . .	Jan. 21,	Feb. 4,	15
489, setter, ...	Hardwick, . .	Feb. 21,	Mar. 11,	19
494, black and tan, . . .	Chelsea, . .	Feb. 29,	Mar. 15,	15
- -	Haverhill, . .	Mar. 1,	Mar. 15,	14
503, collie, ...	Lowell, . . .	Mar. 14,	June 11,	89
509, spaniel, ...	Salem, . . .	Mar. 18,	April 2,	15
spaniel, ...	Boston, . . .	April 1,	July 1,	91
532, dog, ...	Cambridge, . .	May 16,	June 26,	41
horse, ...	Haverhill, . .	April 14,	June 19,	63
545, dog, ...	Lynnfield, . .	June 12,	July 7,	25
565, cat, ...	Cambridge, . .	July 23,	Aug. 1,	7
611, whippet, ...	South Hadley, .	Nov. 9,	Nov. 23,	14
631, mougrel, ...	South Hadley, .	Nov. 27,	-	-
632, pug, ...	Haverhill, . .	Dec. 3,	-	-
dog, ...	Boston, . . .	Dec. 18,	-	-

Respectfully submitted,

WM. F. WHITNEY, M.D.
H. CARLTON SMITH, Ph.G.

BOSTON, MASS., Dec. 31, 1896.

To the Board of Cattle Commissioners, Boston, Mass.

GENTLEMEN: — I have the honor to submit herewith a condensed report on the experimental inoculation of calves with the human tubercle bacillus. These experiments the commission was kind enough to permit me to undertake in the winter of 1895 and the spring of 1896. I assume the liberty of sending you a condensed rather than a detailed report, as the latter can only interest the scientists, and since it may be found in full elsewhere, should any one wish to refer to it.

Yours respectfully,

LANGDON FROTHINGHAM.

Experimental Inoculation of Calves with the Human Tubercle Bacillus.

The opinion has often been advanced that cattle are much less susceptible to the human tubercle bacillus than man is to the bovine.* As far as I have at present examined the literature, I have been unable to find any reference to works which might throw light upon this subject, with the exception of a short report by Smith;† hence it was that the following experiments were begun, with the hope that some data might be obtained which would tend to uphold, or reject, the above theory.

In the following experiments young calves were employed, which were the offsprings of healthy cows. In most instances the mother had been injected with tuberculin, to prove the presence or absence of tuberculosis. In cases where the mother was not subjected to this test, she was, as far as clinical symptoms are evidence of the non-existence of this disease, apparently free from tuberculosis. In the first experiments the calves were also tested with tuberculin. The experiment animals were kept in a building which had never before been used for housing animals, and the milk which these calves were fed upon came from tested cows.

Autopsies were made with the greatest care, that no tuberculous lesion should escape detection; and many suspicious bits of organs were reserved for later microscopic examination, though, as a rule, with negative results.

Experiment No. 1. — Inoculation of Calves with Pure Cultures of the Human Tubercle Bacillus.

This bacillus was obtained directly from the liver of a child, about one year previous to these experiments. The culture used was one month old upon blood serum, and, as near as I was able to ascertain, about the twentieth generation. A suspension of this culture was made in boiled distilled water, and 1 cubic centimeter of this suspension was injected into the calves.

Calf I. (three months old; from tested mother; calf tested with tuberculin one week previous to inoculation). — The inoculation was made by injecting one cubic centimeter of the above suspension of tubercle bacilli into the abdominal cavity. After five weeks this calf was injected with tuberculin, and showed the following reaction: —

* The terms human and bovine tubercle bacillus are used in this article for the sake of convenience, not because the two organisms are to be considered as absolutely different bacteria, though they are, in all probability, varieties, according to virulence of the same bacillus.

† Theo. Smith, "Transactions of Association of American Physicians," 1896.

			Degrees F.
Time:	8.30 P.M.	Normal temperature,	101.1
	7.30 A.M.	After injection,	102.2
	9.30 A.M.	After injection,	105.0
	11.30 A.M.	After injection,	104.1
	1.30 P.M.	After injection,	102.2
	3.30 P.M.	After injection,	101.3

Six weeks after inoculation this animal was killed, and the autopsy was as follows: —

Autopsy. — Beneath the point of inoculation, upon the surface of the rumen, was a firm nodule about the size of a pea, and in the immediate neighborhood another similar but smaller nodule. On the parietal surface of a portion of intestine a similar nodule, about the size of a pea.

In the mesentery was a nodule about the size of a large brown bean. This was irregular or rough in outline, and showed numerous minute more or less elevated tubercles, in which calcification was just beginning. This presented typical microscopic appearances of a tuberculous lesion.

On the parietal surface of the peritoneum there were perhaps twenty minute nodules, grayish-white in color, rounded in form, firm to the touch, and varying in size from almost a pin point to a fairly good-sized pin's head.

On the peritoneal surface of the spleen there were four or five small circumscribed nodules, from the size of a pin's head to that of a very small pea.

No other leisons were found, though a careful search was made, cutting every organ into small pieces.

Microscopic Examination of Above Lesions. — Sections of the nodules on the surface of the intestine and the nodule in the mesentery showed the typical microscopic tubercle, with necrosis, giant cells and bacilli. Although many sections of the other lesions (nodule on rumen, nodules on the spleen and those on the parietal surface of the peritoneum) were carefully studied, I was unable to obtain absolute proof of their tuberculous nature.

Calf II. (about three weeks old; tested with tuberculin one week previous to inoculation; mother not tested). — The inoculation was made exactly as in the case of Calf I. Five weeks after inoculation the animal reacted to tuberculin as follows: —

			Degrees F.
Time:	8.30 P.M.	Normal temperature,	101.4
	7.30 A.M.	After injection,	103.3
	9.30 A.M.	After injection,	103.3
	11.30 A.M.	After injection,	104.0
	1.30 P.M.	After injection,	103.0
	3.30 P.M.	After injection,	103.0

Five months after inoculation this calf was killed, and the result of the autopsy was as follows: —

An inguinal lymphatic gland, on the side corresponding to that upon which the inoculation was made, was enlarged and contained several well-marked caseous tubercles.

The *omentum* was *studded* with nodules of various sizes (from scarcely visible dots to the size of a pin head), many of which were isolated, again occurring as confluent masses. Some of these nodules, when confluent, were the size of a brown bean, and slightly calcified. Similar minute nodules were scattered here and there through the mesentery, only when confluent reaching the size of a pea.

Several mesenteric glands were enlarged, and contained small caseous tubercles; other organs were normal.

Microscopic examination of the nodules in the omentum proved them to be tubercles.

Calf III. (three weeks old; tested one week previous to inoculation; from tested mother). — The inoculation was made by injecting one cubic centimeter of the suspension of tubercle bacilli above described into the trachea. Five weeks later this calf was injected with tuberculin, and reacted as follows: —

			Degrees F
Time:	8.30 P.M.	Normal temperature,	101.0
	7.30 A.M.	After injection,	105.3
	9.30 A.M.	After injection,	105.2
	11.30 A.M.	After injection,	106.2
	1.30 P.M.	After injection,	104.2
	3.30 P.M.	After injection,	105.0

Six weeks after inoculation the animal was killed, and the autopsy was as follows: —

Subcutaneously at the point of inoculation was a tuberculous lesion about the size of a nut, which showed several small centres of caseation.

In the neighboring superficial muscles there were several small nodules, showing beginning caseation, and evidently tuberculous in nature.

Beneath the point of inoculation, in the deeper cervical muscles to the right of the trachea, there was an enlargement the size of a large hen's egg, reaching to the cervical vertebræ. It was fluctuating to the touch, and contained a clear, watery fluid, in which were numerous flat, yellowish-white flakes (later microscopic examination of these flakes showed numerous tubercle bacilli). The wall of this cyst was thick and fibrous, its internal surface

pale and delicately honeycombed, the external irregularly nodulated with small tubercles, undergoing caseation. This whole enlargement contained five such cysts of different sizes.

The lymphatic glands on either side of the trachea, and especially those near the point of inoculation, were enlarged to the size of a horse-chestnut, and upon section showed necrotic areas and calcification.

In the *lungs* were several small, opal white nodules, scarcely the size of a pin's head. These were mostly found in the anterior lobe of the left lung.

In the *liver* were several (fifteen to twenty) small, well-defined, yellowish spots, as a rule pin-head in size, and mostly just beneath the capsule; only three such were found in the deeper parenchyma of the organ.

The *microscopic examination* of the above lesions showed them all to be of a tuberculous nature. The tubercules in the lungs and liver were exceedingly small, but perfectly typical in structure, though it was only after prolonged search that one or two tubercle bacilli were discovered.

CALF IV. (two months old; not tested; not from tested mother). — The inoculation was made into the trachea, as in the preceding case. Tested with tuberculin at the end of five weeks, this animal reacted as follows: —

			Degrees F.
Time:	8.30 P.M.	Normal temperature, . .	102.0
	7.30 A.M.	After injection, ...	104.2
	9.30 A.M.	After injection, ...	105.0
	11.30 A.M.	After injection, ...	104.3
	1.30 P.M.	After injection, ...	104.0
	3.30 P.M.	After injection, ...	104.1

Calf IV. was killed five months after inoculation, and the *autopsy showed absolutely no lesions whatever.* Nothing abnormal could be found in the neighborhood of the point of inoculation, and nothing suspicious was found elsewhere in the body, save a very few yellow spots just beneath the capsule of the liver, and two or three similar ones in the deeper tissue of this organ. These were pin-head in size, and were thought to be tubercles similar to those found in the liver of Calf III.; but later microscopic examination showed them to consist simply of an increase in the connective tissue about some of the blood vessels and neighboring bile-ducts, and in one instance a small abscess. (For the possible explanation of the reaction of this calf to tuberculin, see summary.)

Control Experiments. — As control experiments of the above four, two guinea pigs were inoculated, each with one-half cubic centimeters of the same suspension of human tubercle bacilli that was used to inoculate calves 1 to 4.

Guinea Pig 1 was inoculated by injecting the fluid into the *abdominal cavity*. At the end of four weeks this pig was killed, and the autopsy showed: —

Inguinal glands swollen, but not caseous.

Both testicles markedly tuberculous and caseous.

Tuberculosis of the penis with caseation (tubercle bacilli were plenty in the caseous material of the testicles and penis).

Guinea Pig 2. — One-half cubic centimeter of the above suspension of tubercle bacilli was injected into the *trachea*. Animal killed at the end of three months.

Autopsy. — Tracheal and post-pharyngeal lymphatic glands enlarged, and in one instance caseous (from this, tubercle bacilli were demonstrated in cover-glass preparations).

The *lungs*, *liver* and *spleen* were studded with miliary tubercles.

Experiment II. — Inoculation of calves with human tuberculous sputum.

The sputum used was rich in tubercle bacilli, and but few other organisms were present. The sputum was mixed with boiled, distilled water, and inoculated by means of a hypodermic syringe. A small drop of this mixture showed numerous tubercle bacilli when examined with the microscope.

Calf V. (three weeks old; from tested mother; calf not tested). — Inoculation was made subcutaneously, with two cubic centimeters of the above mixture of sputum and water.

			Degrees F.
Time:	8.30 P.M.	Normal temperature,	102.4
	7.30 A.M.	After injection,	103.3
	9.30 A.M.	After injection,	105.3
	11.30 A.M.	After injection,	105.2
	1.30 P.M.	After injection,	104.2
	3.30 P.M.	After injection,	104.1

This animal was killed at the end of five and one-half months. The autopsy was made by one of the Cattle Commissioners, and he was unable to find any pathological changes, save a slight enlargement of a mediastinal lymphatic gland and a small spot in the liver, which he did not consider a tubercle. A guinea pig was inoculated with pieces of this gland and the lesion in the liver, and at the end of two and a half months this guinea pig was killed, and I was unable to find anything abnormal at the autopsy.

Calf VI. (three weeks old; not tested; from tested mother). —The inoculation was made by injecting two cubic centimeters of the mixture of sputum and water in the trachea.

			Degrees F.
Time:	8.30 P.M.	Normal temperature,	101.4
	7.30 A.M.	After injection,	101.2
	9.30 A.M.	After injection,	106.0
	11.30 A.M.	After injection,	106.2
	1.30 P.M.	After injection,	105.0
	3.30 P.M.	After injection,	105.0

The animal was killed four months and nine days after inoculation.

Autopsy at the Point of Inoculation. — Just beneath the skin a firm, partly calcified and partly caseous tubercular mass, the size of a horse-chestnut. Beneath this in the muscles were numerous small, firm, partly caseous and calcified tubercles, extending for several inches in the long direction of the muscles. No other lesions were found.

Microscopic Examination. — Cover-glass preparations from the caseous material of the lesion at the point of inoculation and the tubercles in the muscles showed numerous tubercle bacilli.

Calf VII. (two and a half weeks old; not tested; from tested mother). — Inoculation the same as the preceding.

			Degrees F.
Time:	8.30 P.M.	Normal temperature,	102.1
	7.30 A.M.	After injection,	102.2
	9.30 A.M.	After injection,	103.0
	11.30 A.M.	After injection,	103.1
	1.30 P.M.	After injection,	102.0
	3.30 P.M.	After injection,	101.2

Killed four months and nine days after inoculation.

Autopsy. — Subcutaneously at the point of inoculation a typical microscopic tubercle the size of a pea. The underlying muscles contained a few small tubercles, mostly more or less calcified. These lesions were similar, but by no means so extensive as in the preceding case.

Liver. — Just beneath the capsule and close to the gall-bladder was a yellowish nodule the size of a very small pea, with an apparently caseous centre. A few other smaller yellowish spots were also found, but all were just beneath the capsule of the liver. No other lesions were found.

Microscopical examination of two of the nodules in the liver showed them to be tubercles in histological structure, though no

bacilli could be found. Sections were also made through other similar-looking lesions, but they proved to be non-tubercular in structure.

CONTROL EXPERIMENTS. — As control experiments of the preceding three, two guinea pigs were inoculated, each with one-half cubic centimeter of the same sputum mixture which had been used for the calves.

Guinea Pig 3 was inoculated subcutaneously. This animal died five days after inoculation.

Autopsy. — Extensive fibrino-purulent inflammation, extending over nearly the whole surface of the abdomen, both subcutaneously and between the abdominal muscles. Microscopic examination of the purulent material showed great numbers of pneumococci, and pure cultures of the same organisms were obtained from the heart's blood. (Cause of death, infection with pneumococci.)

Guinea Pig 4. — Inoculation made into the trachea.

Killed at the end of five and a half weeks.

Autopsy. — At the point of inoculation a tubercular abscess the size of a horse-chestnut. The pus in this abscess contained many tubercle bacilli.

Lungs, *Liver* and *Spleen:* milary tuberculosis.

SUMMARY.

From so few experiments it is impossible to claim any absolute scientific evidence that cattle are less susceptible to the human tubercle bacillus than they are to the bovine. For such a statement to be of scientific importance, many experiments in this line must be made, and, at the same time, calves must be inoculated with the bovine tubercle bacillus for comparison.

Reviewing the results of these few experiments upon calves, we have the following: —

1. Of the four calves inoculated with a pure culture of the human tubercle bacillus, only three showed any post-mortem lesions of tuberculosis, and in no instance were these changes extensive. The most marked lesions were in the immediate vicinity of the point of inoculation (in abdominal inoculation, in the omentum and peritoneum; intratrachial inoculation, in the muscles of the neck and the lymphatic glands of the same region. It is possible that the needle did not enter the trachea in some of these cases.) The lesions elsewhere in the body were very minute, and only found by careful search. There was never anything approaching a general infection, as was the case in one of the control animals (Guinea Pig No. 2). That the lesions in Guinea Pig 1 remain localized in the penis and testicles is inexplicable.

That Calf IV. should have reacted to tuberculin may possibly be explained in one of two ways, considering, of course, that the tuberculin was good and the test properly performed: (*a*) That, at the time of injection of tuberculin, tuberculosis really did exist to some trifling extent, and that before death this or these lesions had completely healed, or (*b*) that some small tuberculous centre escaped detection at autopsy.

2. Of the three calves inoculated with human sputum, rich in tubercle bacilli, one was free from tuberculosis, one showed nothing but local lesions in the neighborhood of the point of inoculation, while the third, besides minor local lesions, had only two to four small tubercles in the liver. On the contrary, one of the control guinea pigs was affected with general tuberculosis, which demonstrates the virulence of the bacilli inoculated, while the other, unfortunately, died of septicæmia.

From these facts we are certainly justified in *concluding*: —

That calves are apparently not particularly susceptible to the human tubercle bacillus. But, whether this non-susceptibility is due to a bacillus of diminished virulence for the bovine, or to the age of the animals experimented upon, or to some other cause, further experiment must demonstrate.

The work of this Board, in the control of animal disease, has become an exceedingly important question, and the close relationship between animal disease and public health is a matter of serious importance. Care should be taken, however, that the important agricultural interests of the Commonwealth are not imperilled.

If it were not for the many interests involved, there would be little question as to the proper method of handling them. The study of the best methods for the control of tuberculosis, for example, is a matter that has attracted a great deal of attention, and in it the student of political economy will find a subject that will tax his ingenuity to the utmost.

The agricultural aspect of the question is an important one. Bang has suggested the possibility of raising a healthy herd from a diseased one; and, where the herd is valuable, his suggestions are worthy of careful and extended experiment.

The advocates of extreme measures, on the other hand, have claimed that, if all the animals in the State were tested with tuberculin, the diseased animals killed, the barns disinfected, only such animals as pass the test allowed to mix

with the herd, and a strict quarantine observed, in a short time the entire State would be cleared up, and that the herds in the State would remain free from disease.

Those who object to this method say that the cost is too great. While it might be possible in certain herds, yet in many barns it is impossible to thoroughly disinfect and renovate them without great expense to the owner. It is difficult to pick out all the diseased animals in one test, and if all animals that reacted to the test were condemned, many of the best milking strains might be destroyed, and whole families that it had taken years of labor to produce would be wiped out of existence.

About a year ago a number of valuable herds in the State were tested with tuberculin, under promise from the owners to strictly observe certain conditions. Among those tested was one belonging to Mr. A, consisting of 81 animals. This herd was carefully tested, and the figures submitted to this Board, and 28 animals considered certainly diseased by the Board were condemned and destroyed, and a number were held for retest. The animals held for retest were kept in a separate pasture, and were not allowed to mingle with the rest of the herd. Of these, 13 animals were retested, condemned by the Board and killed, the others passed as sound. Before these cattle were allowed to join the herd the barn had been thoroughly disinfected, in accordance with the following statement : —

Owner's Statement.

We disinfected the barns in the following manner, August 10, 11 and 12. They were thoroughly washed with soap and water, the corners of cribs and stalls received careful attention. The floor of the stalls was relaid in new plank throughout. We then used Labaraque's disinfecting chlorinated solution in full strength as a disinfectant. We used 8 or 10 barrels of it, and every particle of wood received a generous quantity, after which the windows and doors were stopped securely and chlorine gas was generated for five or six hours. After this the stalls, sides and overhead received a coat of paint or varnish. This barn, in which are always kept the cows in milk, ties up 50 head. It is 101 feet long by 46 wide, and 9 foot post. There are 9 windows on the west side, and 8 on the east side, each 5 by 3 feet, besides win-

dows in the double doors facing south. There is a ventilator in the north end, 15 by 15 inches; two near the middle of the ceiling, 2 by 3 feet; and 2 more, 15 by 15 inches. Besides, there is a ventilating arrangement on each window.

In the original test 5 head were held for retest, only 1 responding. This retest was made Nov. 7, 1895. Four of the Holsteins were slaughtered for beef at one time and another during the winter, and passed inspection at the slaughter houses, and quite a number of the grades have been fatted and killed, with the same result. All of the cattle have been extremely well since the test, and it was extremely satisfactory.

In October of this year, sixteen months after the first test, the farm was again visited, and one lot (of 50 head) was tested. These cattle were in the same barn. The animals tested consisted of 29 of the original lot; of the others, 18 were Vermont cattle, and these had been tested carefully before being shipped, especial pains being taken to secure only healthy animals. Three others, not tested, were introduced into the herd on or about September 30, and at that time Mr. A notified the Board that it was expected that the entire herd would be re-tested immediately. However, because of the difficulty in securing sufficient tuberculin, a delay of a few weeks occurred, and it was not until October that two members of the Board visited the herd and tested the lot. Of the 50 animals tested, 27 reacted, were condemned and killed, 25 of which proved to be tuberculous upon post-mortem examination.

The herd belonging to Mr. B, consisting of 37 animals, was tested by a member of this Board Sept. 5 and 6, 1895. Two animals which reacted were condemned and killed, and proved to be tuberculous upon post-mortem examination.

On Dec. 22 and 23, 1896, the herd was again tested, numbering 25 animals, none of which reacted to the test.

Owner's Statement.

We would say that the stable where our cattle were kept when tested for tuberculosis in September, 1895, was 20 feet wide and 8 feet high. The stalls and mangers are 40 inches wide. The cattle face the barn floor, which is 12 feet wide, with 15 feet space above.

Cattle are fastened with chains when in stalls in the winter, and in the summer by fixed stanchions; mangers for feeding are open directly onto the barn floor.

The front feet of cattle are designed to be three or four inches lower than the manger and barn floor. Mangers are swept clean twice a day.

The fronts of the stalls are provided with upper and lower folding lids, to provide for changes of temperature, ventilation and light. The windows in the rear of the cattle are 30 inches square, and placed on an average of not over 8 feet apart.

Running water in the barn and in the yard, available as weather permits; drainage all that could be desired, being on a side hill.

While the cattle have not been kept all the time in the stable referred to in the data above, their general surroundings and condition have been practically the same.

P.S. One question you ask, as to changes since being tested as referred to. We answer none, with the exception that 2 of the cows now present were bought at Brighton with certificate of tuberculin test, — they were bought the day following the killing of 2 condemned animals at Watertown.

The herd belonging to Mr. C, consisting of 27 animals, was tested Aug. 25 and 26, 1895. Twenty animals reacted to the test and were condemned and killed, post-mortem examination revealing tuberculosis in every case.

On Dec. 21 and 22, 1896, the remainder of the herd, consisting of 9 animals, 7 of which were in the original herd, 2 being tested animals that had been purchased after the test of 1895, was again tested. One reacted and was killed, and found to be tuberculous.

Owner's Statement.

I would say that the barn in which the cattle examined by Mr. Dennen in the summer of 1895 were kept is 100 by 40 feet, with L and lean-to.

The main barn has a driveway the whole length through the middle, with large rolling doors at both ends. The cattle stood on the north-west side, facing the driveway, and were thus in the main barn.

The lean-to is in the rear of the cattle tie-up, and the portion open toward the cattle is cut into open pens for cattle or horses.

There is a cellar under the main barn, open on the south-east side, and into the cellar the manure from the cattle is dropped through scuttles.

There are long windows over the large doors at either end of the driveway, and in the lean-to in the rear of the cattle three double sash windows; also windows at both ends of tie-up.

The cattle pass down to the cellar through a passageway in the lean-to, which is cut off from the tie-up by a rolling door, and from the cellar pass out into the yard on the south-east side of the barn. There is running water in a trough in the yard, where the cattle drink.

There is a small door from one end of the tie-up, leading directly out of doors.

The cattle are tied in stanchions and feed off the floor, with standing partitions to keep each animal's feed separate from the next one.

The sound animals were kept in the pasture after the examination until late in the fall, with the exception of one milch cow bought after the examination, which was put in the barn a little earlier in the fall, and kept at one end of the tie-up, by the open door.

Very soon after the examination the barn was fumigated by our veterinarian. I was not told what he used, but from the description of the way it was done, I think he used chlorine gas.

The barn had the large doors open all summer, and no cattle in it. In the fall, just before the cattle (with the exception of the one milch cow) were put in the barn, the standing partition and floor on which the cattle feed were removed and the boards used for fuel, and new floor and partitions built.

There were formerly doors on the south-east side of the cellar, to close it in in the winter; but during last winter, at least, they were kept open. The barn has a ventilating cupola.

The herd belonging to Mr. D, consisting of 25 animals, was tested Aug. 22 and 23, 1895; 6 animals were condemned and killed, and found to be tuberculous.

The herd was replenished with tested animals, and on Dec. 24 and 25, 1896, was again tested, there being 28 animals on those dates, 5 of which reacted to the tuberculin test.

Owner's Statement.

My stable is 80 feet long by 40 feet wide, with monitor roof. The stables are 9 feet high, and the centre or monitor part is 15 feet high, which gives each cow (25 in number) 1,372 feet air space, and it is lighted with 38 windows (6 lighted 9 by 15 glass), and also 72 lights in doors. There are 3 large ventilators in the monitor part that are never closed, and monitor windows are

arranged for ventilation. An air duct brings fresh air to each manger from outside the barn.

I use the Buckley device for water; two cows drink from each bucket.

All liquid manure is conveyed to a large tank outside the barn, and the manure cellar is well ventilated and well drained.

The herd belonging to Mr. E, after being tested and cleaned up in October, 1894, was retested on March 17 and 18, 1896. There were 80 animals in the herd, 78 of which were tested, 2 animals having a temperature too high at the time to be injected. Fourteen animals reacted or showed a suspicious rise in temperature; they were immediately separated from the remainder of the herd, were again retested June 19 and 20, at which time two were released, three were condemned and 9 were continued in quarantine. On Oct. 7, 8 and 9 these 9 quarantined animals were tested and condemned.

On Aug. 16 and 17 64 of the original herd and 1 animal which had been introduced recently were tested. None of the original animals reacted to the test, while the animal which had been introduced from outside reacted and was condemned, and upon post-mortem was found to be tuberculous.

From these records it will be seen that it requires not one examination alone, but more than one test and most thorough disinfection and renovation before a herd can be pronounced free from disease.

It is, perhaps, not amiss at this time to call the attention of your honorable body to the pamphlet issued jointly by the Board of Agriculture and the Hatch experiment station, on the work done by Professor Bang of Copenhagen.

A similar experiment is reported by Dr. Cooper Curtice in the "Journal of Comparative Medicine" for August, 1896. He reports that a valuable herd of Guernseys, belonging to Mr. R. A. Bordon of Easton, N. Y., were badly affected with tuberculosis. This herd was handled in the manner recommended by Professor Bang, with successful results. In referring to the matter Dr. Curtice says: —

The loss to Mr. Bordon and the State, through tuberculosis causing death of cattle, through the slaughter and separation of

affected cattle, and the loss of milk, has been great, but has been lessened by handling the herd in a conservative manner. The preservation of the blood of the old stock and building of the new herd on the same lines has been a positive saving of qualities it has taken years to gain.

One important part of the work of this Board is that which relates to the supervision of the large corps of inspectors appointed by the various cities and towns, and also under control of the local boards of health. This is the part of the work which is so essential for the protection of the public health. The members of the Board feel that steps should be taken to bring this department up to the highest standard possible.

The local authorities in cities and towns should be urged to appoint men of experience and judgment to this position. It does not do to appoint men who will cater for newspaper notoriety, and it does not do to appoint men for this work who know little and care less about it, or who are appointed for political reasons only.

Under the law, inspectors must be present at the time of slaughter, and inspect the carcasses of all animals slaughtered in slaughter houses. It is their duty under the present law to condemn to the rendering tank the carcass of any animal showing any evidence of tuberculosis, no matter how slight the lesion.

This is a question that should be considered most carefully. The interests at stake are so great that no mere feeling of sentiment should be allowed a place in the matter. The whole question should be carefully weighed and looked at from every possible point of view before deciding what changes in the law, if any, are necessary. The total condemnation of meat is not of so much importance, of course, when only animals condemned by the local inspector are involved, these being only exceptionally fit for beef; but when one considers that a large percentage of valuable herds may be condemned, each individual animal of which, to all appearances, is in perfect physical condition, and on autopsy a number are found to be nearly free from disease, in the opinion of the Board, under a proper system of inspection the sale of such meat might be allowed.

Another important part of the work of the local inspectors is the inspection of the milch herds. In this connection the Board would specially call attention to the necessity of making a careful examination of the udder, and the immediate quarantining of the cow in which any abnormal condition of this organ is found. · Cows showing any physical evidence of disease should immediately be quarantined, and in questionable cases, tested with tuberculin. No cows in a sickly or unhealthy condition are fit for dairy purposes, and their use as dairy cows should be prohibited.

A great deal has been made of Ernst and Peters' experiments at Mattapan, conducted under the auspices of the Society for Promoting Agriculture. In these experiments 36 cows in all were experimented with, and the bacillus of tuberculosis was found in the milk of 12 different animals.

Experiments were made by inoculating 88 guinea pigs with milk from 15 of these tuberculous cows. The milk from 6 was found capable of producing the disease, and 12 of these 88 guinea pigs became infected.

In another series of experiments, 90 rabbits were inoculated with milk from 19 different tuberculous cows. The milk of only 4 of the cows produced the disease, and only 6 of the 90 rabbits became infected.

Again, 48 rabbits were fed with milk from 5 tuberculous cows, and with milk known to be infected, and only 2 rabbits became diseased; both of these rabbits were fed on milk from the same cow (cow E), which was badly diseased.

Twelve healthy pigs fed on milk from these same cows gave a larger proportion of cases, 5 out of the 12 becoming tuberculous; but it should be noticed that 3 of the 5 were fed on milk from one cow (cow E). Further, it was milk from this same cow that infected the rabbits in the last series of experiments referred to.

It should be remarked that these experiments were carried on with the object of showing only that cow's milk may be dangerous even when the udder is not affected. Now, it must be remembered that at that time tuberculin was not known as a diagnostic agent for the detection of tuberculosis, and all of the cows used in these experiments were picked out by physical examination alone, and nearly all were badly diseased cows with generalized tuberculosis; while a large

proportion of cases of tuberculosis picked out by tuberculin, and showing no physical evidence of disease, are incipient cases, and may not be a source of danger. Often a careful examination has to be made before any pathological lesion can be detected on post-mortem examination. It is a curious fact that in a majority of cases where the reaction is high and well marked only slight tubercular lesions are found, while in such cases as are well advanced there is frequently no apparently characteristic reaction from tuberculin, and the examiner has to depend upon a physical examination alone to detect the disease. It is in these latter cases that the greater danger lies. If, then, care is taken to condemn all such cases, and the milk supply is obtained only from such animals as are in good general health and show no physical evidence of disease, the danger is very much reduced.

In taking this view of the matter, the Board does not wish to be understood as meaning that no further advance can be made in this direction; but, realizing that pulmonary consumption in the human family has steadily and uniformly decreased during the past forty-five years, the maximum and minimum death rates being 42.7 per ten thousand of the population in 1853, and 22.7 in 1893, it believes that there is no need for the adoption of more radical methods at the present time; and, further, it believes that advances can be made in other directions which will give better protection to the public, and result in great and immediate benefit to both producer and consumer.

Tuberculosis is not by any means the only danger to which the consumer is exposed through the use of impure milk. For years past the most fatal disease among infants has been milk diarrhœa, or cholera infantum. In this connection it has been claimed by certain parties that cholera infantum or milk diarrhœa is a disease of tubercular origin. This is a fallacy, and is misleading. Cholera infantum, as it is usually understood, refers to milk diarrhœa, or, more properly, acute mycotic diarrhœa of bacterial origin. Milk diarrhœa is not an inflammatory disease; there is little or no time for pathological changes to take place, and few pathological changes are observed after death. It is an acute

ptomaine poisoning, caused by the absorption of the products of fermentation, and due, as a rule, to improper feeding, and the presence of impurities and immense numbers of bacteria in the milk. The symptoms of milk diarrhœa are acute, and are not those of tuberculosis of the intestines.

Milk diarrhœa is probably the most common disease to which children are subject. In this connection we would call your attention to the mortality report of the Massachusetts Board of Health for 1895.

In this report it is shown that there were 5,463 deaths from phthisis at all ages, 2,676 deaths from cholera infantum, 1,801 deaths from diphtheria and croup, 748 deaths from typhoid fever, 649 deaths from scarlet-fever, and 98 deaths from measles.

In this report we see cholera infantum placed next to phthisis in the death rate. Now, in considering this subject, it must be remembered that the latest statistics show that by far the largest proportion of cases of phthisis occur in people who have recently moved into houses previously occupied by consumptives; while, on the other hand, cholera infantum is due almost solely to the ingestion of impure milk. Further, the deaths from phthisis include deaths at all ages, while cholera infantum occurs only in children under five years and practically under one year old.

In New Hampshire the proportion of deaths from cholera infantum is greater; for the year ending 1891 the report shows 695 deaths from consumption and 486 deaths from cholera infantum. The report then remarks: "Cholera infantum was the cause of more than one-third of all the deaths from prominent zymotic diseases in New Hampshire in 1891."

In Ontario, for the year ending 1892, in a population of over 2,000,000, phthisis caused 2,592 deaths and cholera infantum 670; but among the 23,190 children under one year old cholera infantum caused 600 deaths, while phthisis caused 283 deaths.

These figures are pregnant with meaning. Cholera infantum, or milk diarrhœa, is purely a disease of infants, due as a rule to improper feeding with impure milk. In Massachusetts it was the cause of 2,676 out of 11,435 deaths from the six most prominent diseases; the cause of one-fourth of all deaths from all zymotic diseases in New Hampshire in 1891.

Milk diarrhœa is distinctly a preventable disease, and is due to uncleanliness and filthy surroundings and to want of

attention in the care of milk. It is not enough to scald milk cans and wipe them out with a wet cloth, as the cloth will reinfect the cans, and destroy any good that might have resulted from previous cleansing.

To understand this matter thoroughly, it is necessary to recollect that the science of bacteriology has made wonderful strides of recent years. The study of these minute organisms is an important one. They are everywhere around us, and play an unrecognized though important part in every-day life.

The souring and curdling of milk is due to the development of bacteria which find their way into milk, either during or after milking; not only that, but the pleasant flavor and delicate aroma of good butter and cheese is due to the development of certain varieties of these organisms. On the other hand, other varieties, the bacillus *Coli communis*, for example, which is present in large numbers in the fecal matter, will spoil both butter and cheese; and it is probably this same *Coli bacillus* that is mainly responsible for the large proportion of cases of milk diarrhœa in infants, which occur so frequently during the summer months.

There are many ways by which various kinds of bacteria get into milk. A dairyman has only to look in the strainer, after milking, to find hair, dirt, scurf, scabs from sores and fecal matter in every pail, and all these are swarming with bacteria. Then, again, the milker's hands are rarely washed before milking; his clothes are dirty; greasy and soiled overalls are worn while he is at work; milk cans and milking utensils are frequently washed with water far from clean; even if scalded, they are often rinsed with water from a polluted well.

Then, after being shipped to Boston, the method of testing milk is very unreliable. In cold weather bacteria in the milk do not develop, and the milk tastes sweet; but, if the temperature is raised the bacteria will develop rapidly. In this way, milk when first brought in may appear sweet, but after it is mixed and the temperature raised, the bacteria will develop, and the entire quantity will be contaminated. This is a matter that ought to be taken up by the producer himself, and it might well be attended to by the New Eng-

land Milk Producers' Union, and, as a step in this direction, in a pamphlet issued by this union under the heading "What milk producers want," we find, in Section V., among the objects of the union, it is proposed "to insure better care by peddlers in the distribution of milk." This is the entering wedge; it is the recognition of the necessity for some action in the matter. The interests of both the producer and the consumer are identified in this matter, and the sooner both parties realize this fact, and co-operate with one another, the better it will be for both.

Among the many sources of contamination by which milk may become infected, probably none is more serious than the contamination of the water supply. In this connection, we quote from the "Farmers' Bulletin," No. 43, from the United States Department of Agriculture, on "The sewage disposal on the farm."

The chief dangers which threaten rural inhabitants are those arising from polluted drinking water. This is infected from the household excrement and barn-yard drainings, as will be described further on, and its use leads in the main to bowel disturbances, typhoid fever and dysenteric affections. It might be claimed that in an isolated homestead the danger is absent, because the night soil from the healthy household cannot contain the germs of typhoid fever, and therefore the well water cannot receive them from leaky cesspools and surface drainage This would be true if the family lived secluded from other human beings. As the case stands, there is much more communication than is at first thought supposed. There is more or less coming and going of farm hands and other hired help, of tramps, peddlers, etc. The farmer travels more than formerly. He frequently visits neighboring communities. The children go to school. As it has been shown, there may be mild cases of typhoid fever passing unnoticed, perhaps, in a farm hand, for example, who leaves on account of ill health, and who has meanwhile, in his discharges, deposited the germs of this disease on the premises. It is evident that isolation nowadays does not exist except in remote thinly settled regions, and that disease germs may make themselves suddenly felt in an unexpected manner in any farmhouse.

There are other important reasons, however, why rural sanitation should not be neglected. The health of the large communities of people who draw their food supply from the country is in a

measure dependent on the health of the farming community. There is scarcely a city child who is not, in a degree, dependent for its health on the sanitary conditions prevailing in the house of the dairyman. Milk has been repeatedly shown to be the means of distributing typhoid fever and other diseases. Any vegetable foods from the farm, eaten raw, are liable to become carriers of infection under unsanitary conditions.

In many parts of our country other causes operate in making the health of many people depend on the proprieties of country homes. The thousands of city people who flock every summer to the country, and bring to the farming community considerable sums of money, should be properly protected against the dangers of polluted water and infected milk by the adoption of suitable methods of sewage disposal. Too frequently those who left the city for the purpose of gaining strength by breathing pure air, drinking pure water and eating pure food, only return with the germs of an often fatal disease within them, to swell the typhoid statistics of our large cities.

. . . .

The next subject to claim our attention is the protection of the sources of drinking water. In the country water, as a rule, is obtained from wells and springs. The important bearing upon well water of soil purity demands a few explanatory remarks concerning the origin of well water. Wells are excavations made into the ground to a variable depth until water is reached. This water is denominated ground and subsoil water. Its origin may be better understood if for the moment we conceive the surface of the earth as more or less irregular, and entirely impervious to water. The rain would collect on this surface and form lakes, ponds and streams, according to the configuration of the surface. If, now, we conceive this surface covered with sand or other porous earth, to a greater or lesser height, and the top of this be considered the earth's surface, the water will remain in the same position, but it will be buried within, and fill the pores of the overlying soil, as subterranean lakes, ponds and streams. In digging a well we remove the porous layer of earth until we reach these subterranean streams or reservoirs of ground water. If the above description be thoroughly understood, the condition under which well water may be obtained at different depths will become intelligible, and it will also appear plain why ground water may flow at any surface stream and pick up on its way various substances which have percolated the ground.

Wells are exposed to contamination in two ways. The surface water from rain, house slops and barn-yard drainage may find its

way into the well at or near the surface of the ground; or, the ground-water stream supplying the well with water may in its subterranean movements, encounter cesspools or seepings from cesspools, and carry with it soluble and suspended particles, some of which may enter the well. There can be no doubt that a large percentage of the wells are exposed to contamination with refuse matter in the manner described; and it now remains to gauge the danger to health and life which may be carried in the contaminating substance. The danger of typhoid fever bacteria entering the water has already been mentioned. These may be washed in from the surface, or they may pass from cesspools near by through fissures in the ground, passages dug by rats, etc. Whether such bacteria can pass through the pores of a compact, unbroken soil from a cesspool to a well near it is a matter not fully settled. Since, however, the actual condition of the deeper layers of the soil between cesspool and well cannot be known, it becomes imperative to prevent all pollution of the ground-water current supplying wells, by either abolishing the cesspools or else placing them at a considerable distance from all sources of water.

Besides typhoid fever bacteria, those organisms which cause digestive disturbances and severer troubles, such as diarrhœa, dysentery and possibly other unknown diseases, may be carried into well water. During cholera epidemics, polluted wells might form centres of infection. Eggs of animal parasites may be washed in from the surface. Again, the barn-yard manure, representing the mixed excrement of various animals, may, under certain conditions, be bearers of disease germs, and such excrement should, under no condition, be looked upon as entirely harmless to human beings.

Besides the protection of ground water near the well from pollution emanating from cesspools, etc., the surface of the ground about the well should be kept free from manure, slops and other waste water; hence the well should not be dug under or close by the house, saturated with manure. It should be surrounded by turf, and not by richly manured, cultivated or irrigated soil. The ground immediately around it should slope gently away from it, and be paved if possible. The waste water from the well should not be allowed to soak into the ground, but should be collected in water-tight receptacles, or else conducted at least twenty-five feet away in open or closed channels which are water-tight.

It seems to us that this subject is important, and during the past year considerable pains were taken to collect data on this subject, etc. For the full report we must refer you

to pages 544–551. We would call your special attention, however, to one of these cases reported.

In this (Quincy) case it will be seen that the drain from the kitchen sink, the privy vault and the manure pile are all in the neighborhood of the well, and an analysis of the water shows it to contain a large amount of organic matter. Your attention is called to the milk cans hanging to dry and air at the end of the house. These cans are rinsed daily, after washing, with water from the well. It can easily be seen how dangerous this water would become in case of sickness in the family. Many outbreaks of typhoid fever can be traced to this source of infection.

Prof. W. T. Sedgwick, in a paper on the milk supply problem, read before the Society of Arts, in Boston, notices this same danger: —

In 1890 he made a careful bacteriological investigation of the milk supply of Boston, which showed that much of the milk publicly sold was far from fresh, and was subject to contamination by the germs of disease. Since that time several serious epidemics of typhoid fever in Massachusetts have been traced by him to the use of infected milk, and grave suspicions, to say the least, of the spread of tuberculosis by means of the milk supply, have been raised and have not been allayed. . . .

As a matter of fact, within the last few years a number of epidemics have been traced to some man in the milk house who was suffering from typhoid fever, while working over the milk, and it is believed that slight infections of this kind occur oftener than is generally supposed.

In the Journal of Comparative Medicine, for December, 1896: —

Typhoid infection in a two and a half year old child from drinking milk not thoroughly boiled. In May, 1892, a girl two and a half years old became suddenly sick from symptoms of irritation of the bowels, relieved by evacuations and emissions of urine. The treatment adopted, in which other food replaced milk, quickly diminished the symptoms, which reappeared again as soon as milk was given. Marked typhoid infection also developed, lasting for some weeks. At the end of the fifth week the child was convalescent. For the reason that the child had been fed exclusively with milk, and because the symptoms after disappearing suddenly reappeared when the milk diet was recommended, the physician

deemed himself justified in concluding that the milk contained the injurious elements. A further reason was found in the fact that the four-year-old sister of the patient, who had drunk of the same milk, but not such a large quantity also suffered from diarrhœa at the same time that her younger sister was sick. The bacteriological investigation of the suspected milk and evacuations of the patient gave the following results: in the milk a bacterium was found in great quantity, which presented the morphological and biological characteristics of the bacterium *coli commune*. In the evacuations the same bacteria were found, as well as in the blood of mice which had been infected with the fecal matter of the patient. It is a noteworthy fact that these bacteria have been found in a virulent condition in milk which had been boiled. This can only be explained on the ground that the milk had not been boiled enough, or that the boiled milk after it had become cool had been poured back into the can, which had not been cleansed sufficiently.

Perhaps one of the most interesting cases of typhoid fever, due to infection from milk, occurred in Plympton, England, August, 1870. A certain milk dealer sold milk to one hundred and forty-five families, and of the one hundred and forty-five, seventy contracted the disease. The way the disease picked out the customers of the dairy in the various streets was most striking. In one long street the milkman supplied three families, and two of them were affected. In a block of twenty-five houses he supplied four families, and they were all attacked. In a new neighborhood, where there were about seventy houses, he supplied four families, and three had the disease. In a square of fifty-nine houses he supplied four, and all had it, and so on. On the other hand, there were scarcely any cases in those families supplied from other sources.

The infection in this case was traced to an underground tank in the cow house, which was contaminated from a leaking sewer, and the water in the tank had been used to wash the milk pails, and in this way the milk became infected.

Changes in the Board.

The term of Dr. Charles P. Lyman of Boston as a member of this Board expired in September, and Acting Governor Wolcott appointed Dr. John M. Parker of Haverhill

to the vacancy September 30. He was confirmed the Thursday following and qualified October 26, attending a meeting of the Board on that date for the first time.

The term of Mr. L. F. Herrick also expired in September, and he was reappointed.

The office of secretary being vacated by Dr. Lyman's retirement, Commissioner L. F. Herrick was elected to the vacancy. Dr. Frederick H. Osgood of Brookline tendered his resignation as a member of the Board November 30, and it was accepted by the acting governor December 7.

The acting governor appointed Dr. Austin Peters of Jamaica Plain a member of the Board, to fill the vacancy thus caused, December 10. He was confirmed December 17 and qualified December 19. He attended a meeting of the Board on that day.

Dr. Osgood's retirement leaving the chairmanship of the Board vacant, Dr. Peters was elected chairman, and, Mr. Herrick declining to continue in the position of secretary, Dr. Parker was elected to that vacancy. Both these elections were unanimous.

At the beginning of the year the Board found itself with several hundred animals in quarantine, at the expense of the State, and without funds to defray the expense incident to testing them and destroying those found diseased. While the Legislature made an early appropriation of $50,000 for these expenses, the inspectors throughout the State, who are independent public officers, were constantly quarantining more suspected animals; so that, while the Board was able to dispose of a considerable portion of the cases, it was not until the regular appropriation was made, June 5, that it was possible to entirely clear away this accumulation of work. At this time the quarantine expense on animals thus held amounted to $28,223.43.

To obviate the recurrence of this condition of affairs, the Legislature passed the following, which was approved June 2, 1896: —

If the sum hereby appropriated shall be expended before the first day of January in the year eighteen hundred and ninety-seven, the auditor shall immediately certify that fact to the Board of Cattle Commissioners. Upon receipt of such certification,

said Board shall immediately notify each city and town and each inspector throughout the Commonwealth that said appropriation is exhausted, and thereafter no Massachusetts cattle shall be quarantined until a further appropriation is made, and all Massachusetts cattle quarantined at the time such notification is issued shall be immediately released.

During the year ending Dec. 15, 1896, the Board had at its disposal appropriations amounting to $300,000. There has been paid for 5,198 head of cattle condemned as tuberculous the sum of $173,206.35; there are at the present time 550 warrants for cattle which have been condemned and killed, in process of approval, amounting to $16,040.25; there has been paid for quarantine expense on animals $28,223.43, making a total of $217,470.03 which has been returned to the cattle owners of the Commonwealth.

The Board has asked the Sergeant-at-Arms for quarters at the State House, and have his assurance that at an early date the request will be granted. It is believed that with this change of location the work of the Board can be more satisfactorily handled, and that its administrative expenses can be materially reduced.

The Board is of the opinion that such laboratory work as will be necessary in the future can be accomplished with comparatively slight expense, and proposes to rearrange this department with this view at an early date.

The Board is convinced that the restrictions against the testing of herds upon the request of the owners, which was a provision in the bill of last year making the appropriation for the Board, should not be re-enacted. The Board should have power to do this work wherever owners will bind themselves to follow it by a strict compliance with the sanitary regulations of the Board.

Respectfully submitted,

AUSTIN PETERS, *Chairman*,
JOHN M. PARKER, *Secretary*,
MAURICE O'CONNELL,
LEANDER F. HERRICK,
CHARLES A. DENNEN,
Board of Cattle Commissioners.

INDEX TO SECRETARY'S REPORT.

PUBLIC DOCUMENT . . . . No. 33.

NINTH ANNUAL REPORT

OF THE

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

JANUARY, 1897.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
18 POST OFFICE SQUARE.
1897.

HATCH EXPERIMENT STATION

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE,

AMHERST, MASS.

By act of the General Court, the Hatch Experiment Station and the State Experiment Station have been consolidated, under the name of the Hatch Experiment Station of the Massachusetts Agricultural College. Several new divisions have been created and the scope of others has been enlarged. To the horticultural has been added the duty of testing varieties of vegetables and seeds. The chemical has been divided, and a new division, "Foods and Feeding," has been established. The botanical, including plant physiology and disease, has been restored after temporary suspension.

The officers are: —

Henry H. Goodell, LL.D.,	*Director.*
William P. Brooks, B.Sc.,	*Agriculturist.*
George E. Stone, Ph.D.,	*Botanist.*
Charles A. Goessmann, Ph.D., LL.D.,	*Chemist* (fertilizers).
Joseph B. Lindsey, Ph.D.,	*Chemist* (foods and feeding).
Charles H. Fernald, Ph.D.,	*Entomologist.*
Samuel T. Maynard, B.Sc.,	*Horticulturist.*
Leonard Metcalf, B.S.,	*Meteorologist.*
Henry M. Thomson, B.Sc.,	*Assistant Agriculturist.*
Ralph E. Smith, B.Sc.,	*Assistant Botanist.*
Henri D. Haskins, B.Sc.,	*Assistant Chemist* (fertilizers).
Robert H. Smith, B.Sc.,	*Assistant Chemist* (fertilizers).
Edward B. Holland, B.Sc.,	*Assistant Chemist* (foods and feeding).
Robert A. Cooley, B.Sc.,	*Assistant Entomologist.*
Joseph H. Putnam, B.Sc.,	*Assistant Horticulturist.*
Benjamin K. Jones, B.Sc.,	*Assistant in Foods and Feeding.*

The co-operation and assistance of farmers, fruit growers, horticulturists and all interested, directly or indirectly, in agriculture, are earnestly requested. Communications may be addressed to the "Hatch Experiment Station, Amherst, Mass."

BULLETINS ISSUED, 1887–97.

No. 1. Protection of peach buds; effect of girdling; jumping sumac beetle.

No. 2. Grape-vine leaf hoppers; ants; poisonous doses of insecticides, and treatment; report on standard varieties of fruit.

No. 3. Bovine tuberculosis.

No. 4. Steam heat *v.* hot water for heating greenhouses; evaporated sulphur as an insecticide; plant diseases.

No. 5. Buffalo carpet beetle; larder beetle; clothes moth.

No. 6. Steam *v.* hot water; fungous diseases of plants.

No. 7. Tests of small fruits and vegetables; girdling; protection of fruit trees from animals; Japanese millets and beans; the gypsy moth.

No. 8. Steam *v.* hot water; peach yellows; danger from the use of milk coming from tuberculous cows.

No. 9. Soil tests.

No. 10. Special fertilizers for greenhouse crops; report on small fruits.

No. 11. Strength of rennet; hay caps; potato rot; fungicides and insecticides for fruit.

No. 12. Bud moth; spittle insects; squash bug; pea and bean weevil; May beetle; curculio; onion maggot; cabbage butterfly; tent caterpillar; forest tent caterpillar; stalk borer; pyramidal grape-vine caterpillar; grape-berry moth; codling moth; cabbage-leaf miner; gartered plume moth.

No. 13. Directions for using fungicides and insecticides.

No. 14. Fertilizers for corn.

No. 15. Over-bench *v.* under-bench heating; special fertilizers for plants under glass; varieties of strawberries, blackberries, raspberries.

No. 16. Summary of results in electro-culture.

No. 17. Fungicides and insecticides; varieties of grapes and peaches; protection of peach buds; copper on sprayed fruit; Siberian crab as a stock; girdling grape vines; spraying apparatus.

No. 18. Fertilizers for potatoes, oats and corn; muriate of potash; corn and millet as grain crops; report on oats, hemp, flax, English wheats, Japanese millets and beans.

No. 19. Gypsy moth; effect of Paris green on foliage; Barnard's insect trap; lice and spiders on rose bushes; kerosene emulsion; effects of Paris green on tent caterpillars; cranberry insects.
No. 20. Canker worms; tent caterpillar; fall web worm; tussock moths.
No. 21. Bordeaux mixture; ammoniacal carbonate of ammonia; copper sulphate; fruits.
No. 22. Small fruits.
No. 23. Electro-culture.
No. 24. Arsenate of lead; Paris green and lime; Jamestown weed; horn fly.
No. 25. Fungicides and insecticides; grape tests.
No. 26. Strawberries; blackberries; raspberries.
No. 27. Tuberculosis in college herd; tuberculin in diagnosis; bovine rabies; poisoning by nitrate of soda.
No. 28. Canker, army and corn worms; red-humped apple-tree caterpillar; antiopa butterfly; currant stem girdler; imported elm-bark louse; greenhouse orthezia.
No. 29. Fungicides and insecticides; new spraying pump; spraying calendar.
No. 30. Fertilizer analyses.
No. 31. Fertilizer analyses.
No. 32. Fertilizer analyses.
No. 33. Glossary of fodder terms.
No. 34. Fertilizer analyses; analyses of manurial substances.
No. 35. Agricultural value of bone meal.
No. 36. Imported elm-leaf beetle; maple pseudococcus; abbot sphinx; San José scale.
No. 37. Report on fruits, insecticides and fungicides.
No. 38. Fertilizer analyses; composition of Paris green; action of muriate of potash on the lime resources of the soil.
No. 39. Economic feeding of milch cows.
No. 40. Fertilizer analyses.
No. 41. On the use of tuberculin (translated from Dr. Bang).
No. 42. Fertilizer analyses; fertilizer laws.
No. 43. Effects of electricity on germination of seeds.

Special Bulletins.

Index, 1888 to 1895.

Gypsy moth.

The most profitable use of commercial fertilizers (translated from Paul Wagner).

The true value of green manuring (translated from Julius Kuehn).

Of the above bulletins, the edition of No. 2 is entirely exhausted; Nos. 1, 3–24 inclusive, 26, 30–32 inclusive and 34 are nearly exhausted, a few copies of each remaining, which can only be supplied to complete sets for libraries; Nos. 25, 27–29 inclusive, 33, 35–43 inclusive, and the index number are still in stock.

ANNUAL REPORT

Of George F. Mills, *Treasurer pro tem.*, of the Hatch Experiment Station of Massachusetts Agricultural College,

For the Year ending June 30, 1896.

Cash received from United States treasurer,		$15,000 00
Cash paid for salaries,	$5,218 50	
for labor,	3,541 94	
for publications,	2,816 86	
for postage and stationery,	284 66	
for freight and express,	185 60	
for heat, light and water,	110 15	
for seeds, plants and sundry supplies,	572 98	
for fertilizers,	96 88	
for feeding stuffs,	291 51	
for library,	686 83	
for tools, implements and machinery,	326 63	
for furniture and fixtures,	70 47	
for scientific apparatus,	96 00	
for travelling expenses,	92 31	
for contingent expenses,	155 11	
for building and repairs,	453 57	
		$15,000 00
On hand July 1, 1895: —		
Received from Dr. Goessmann,	$1,704 37	
from State treasurer,	10,000 00	
from fertilizer fees,	3,627 17	
from farm products,	1,204 46	
from miscellaneous,	733 64	
		$17,269 64
Cash paid for salaries,	$9,502 66	
for labor,	434 02	
for publications,	115 37	
for postage and stationery,	186 64	
for freight and express,	127 77	
Amounts carried forward,	$10,366 46	$17,269 64

Amounts brought forward,		$10,366 46	$17,269 64
Cash paid	for heat, light and water,	287 31	
	for chemical supplies,	901 98	
	for seeds, plants and sundry supplies,	475 34	
	for fertilizers,	825 01	
	for feeding stuffs,	484 58	
	for library,	332 86	
	for tools, implements and machinery,	15 15	
	for furniture and fixtures,	311 98	
	for scientific apparatus,	15 50	
	for live stock,	365 00	
	for travelling expenses,	17 19	
	for contingent expenses,	491 66	
	for building and repairs,	1,336 70	
Balance,		1,042 92	
			$17,269 64

AMHERST, MASS., Aug. 31, 1896.

I, Charles A. Gleason, duly appointed auditor of the corporation, do hereby certify that I have examined the books and accounts of the Hatch Experiment Station of the Massachusetts Agricultural College for the fiscal year ending June 30, 1896; that I have found the books well kept and the accounts correctly classified as above, and that the receipts for the year are shown to be $32,269.64 and the corresponding disbursements $31,226.72 All the proper vouchers are on file, and have been by me examined and found to be correct, there being a balance of $1,042.92 on accounts of the fiscal year ending June 30, 1896.

CHARLES A. GLEASON,
Auditor.

REPORT OF THE AGRICULTURIST.

WILLIAM P. BROOKS.

Leading Results and Conclusions based upon the Experiments outlined in the Report of the Agriculturist.

Cabbages and Swedes.

1. Soil-test work indicates that fertilizers for these crops should be particularly rich in available phosphoric acid and potash.

2. The muriate of potash has been found a useful form in which to supply the potash.

3. The material used to supply phosphoric acid in our experiment was dissolved bone-black, but it is believed that other available phosphoric acid fertilizers will be found equally serviceable.

Soy Beans.

1. Soil-test work shows a very intimate connection between potash supply and the growth of this crop.

2. The form in which potash has been supplied in soil tests is the muriate, but other experiments indicate that the sulphate is superior to this salt for beans.

Corn.

Soil Test with Corn. — A carefully conducted soil test with corn in Norwell, Plymouth County, upon somewhat exhausted soil, previously for many years in grass, shows potash to be here the controlling element for this crop, as in so many other places.

Hill v. Drill Culture of Corn. — Experiments continued in different fields from five to six years indicate that corn planted in drills will usually produce larger crops than when planted in hills. This increase is most marked, as might be expected, in case of the stover, but applies to the grain as well.

Green Manuring in Continuous Corn Culture.

1. *White mustard*, sown in standing corn at the time of the last cultivation, helps to keep down weeds, furnishes useful pasturage for sheep or young stock, conserves soil nitrogen, does not decrease the yield of corn the year it is sown, and can be counted upon to improve the soil if turned under. *It also helps largely to prevent soil washing in winter.*

2. *Crimson and sweet clovers* have not proved to be suited for green manuring crops in continuous corn culture, since they are not sufficiently hardy.

Variety Tests.

Potatoes.

1. Of 60 varieties of potatoes cultivated, but 5 showed themselves to be in any marked degree superior as crop producers to the Early Rose and Beauty of Hebron.

2. These, with rates of yield per acre in bushels, are as follows: Carman No. 1, merchantable, 355.3; small, 28.6. Fillbasket, merchantable, 336; small, 24.5. New Satisfaction, merchantable, 306; small, 25.7. Early Maine, merchantable, 305.1; small, 35.6. Dutton's Seedling, merchantable, 304.5; small, 19.8.

3. The Early Rose yielded: merchantable, 292.8; small, 21 bushels. The Beauty of Hebron (somewhat injured by proximity to other crops), merchantable, 275.9; small, 18.7 bushels.

4. The varieties tested showed no very marked differences in respect to ability to resist blight.

Corn.

1. Of 21 varieties of Flint corn cultivated, 7, or $33\frac{1}{3}$ per cent., gave a yield at the rate of $83\frac{1}{3}$ bushels per acre or over.

2. Of 46 varieties of Dent corn, 13, or 28 per cent., equalled or exceeded the same rate of production.

3. Among the best of the Flint varieties are the White Flint,* Sanford,* Compton's Early, Giant Long White and Longfellow.

4. Among the best Dent varieties as indicated by our trial are Yellow Rose, Mastodon, Reed's Yellow Dent, New Golden Triumph and Leaming; but Sibley's Pride of the North, though standing ninth in weight of ears produced, matured among the earliest, and is undoubtedly one of the best Dent varieties for grain production.

Clovers.

1. Crimson clover can be grown as an annual, and gives one good crop; but it will not usually survive our winters, and does not, therefore, at present appear to be worthy of attention as a fodder crop.

2. The mammoth clover exceeds the common red in productive capacity, having produced more hay in two cuttings than the common red in three. It is especially to be commended for sowing with timothy.

3. Alsike clover appears not to be as long lived as the mammoth and the common red.

Millets.

1. For seed production the Japanese "barn-yard" and the Japanese "common" again show their superiority, producing respectively 57 and 53.3 bushels per acre.

2. As a result of a careful comparison of 17 varieties, the Japanese white-seeded panicle millet and the Japanese barn-yard millet are found to lead all other varieties in productive capacity.

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* These two are apparently nearly or quite identical.

New Crops.

The flat pea (*Lathyrus sylvestris*) has not been found to be of value as a fodder crop.

The horse bean (*Vicia faba*) has not been found to do well.

Sorghum of different varieties appears inferior to Indian corn as a fodder crop.

Saccaline is found not to be hardy and will probably not prove of value as a fodder crop.

Miscellaneous.

Fungiroid has not been found effective in preventing potato blight.

Sulphur applied in the drill did not prevent scab of potatoes.

The Symmes' hay cap is preferred to cloth caps.

Soil Tests.

Soil tests, upon the plan outlined in previous reports, have been carried on upon a somewhat less extensive scale. We have had four such experiments this year: one with soy beans and one with turnips and cabbages upon our own grounds; and one in Montague and another in Norwell, with corn. Circumstances compelled the cessation of the work in Concord, Worcester and Shelburne, and it was not considered important to continue it longer in Hadley, as this town lies so near Amherst, and as the soil upon which we were working gave results so entirely similar to those obtained upon our own. The main conclusions justified by the results of the past season are as follows: —

1. Potash is the controlling element in the case of the corn crop in Norwell.

2. Nitrogen appears to have been the most useful element for the corn crop in Montague; but the results are obscured in a measure by differences in natural fertility in different parts of the field.

3. A combination of potash and phosphoric acid appears to be necessary to materially increase either the cabbage or the turnip crops in Amherst.

4. Potash proves much the most useful single element for the soy-bean crop in Amherst.

1. *Soil Tests with Corn.*

In Montague the experiment was carried out upon land belonging to Mr. H. M. Lyman, and is the first year this land has been used in such work. The field selected is level, and it was thought it would be suited for the purpose, though it had been more recently manured than we would have liked. The results show that it was not as even in fertility as is desirable. The yields of the five scattered nothing plats were respectively at the rates of 12, 10.5, 19, 32 and 19.9 bushels per acre. Under such conditions, we are not justified in attempting to draw general conclusions. The nitrate of soda appears to have produced an average increase at the rate of: grain, 11 bushels; stover, 158.5 pounds per acre. The average effect of the phosphate appears to have been a decrease in both grain and stover, while the potash appears to have increased the stover slightly but not the grain.

In Norwell the experiment was carried out upon land belonging to the writer, and is the first year this land has been used in such work. The field was in grass in 1895, and is in rather a low state of fertility. Throughout the season potash seemed to be the controlling element. At the time of harvesting, plat 5, receiving muriate of potash alone at the rate of 160 pounds per acre, appeared to be as heavy as either plats 10 or 13, receiving respectively complete fertilizer and stable manure. Owing to a slight accident at the time of harvesting, figures cannot be published at this time.

2. *Soil Test with Cabbages.*

This test occupied one-half of the land which has been designated the "north acre" in previous reports, the other half being occupied with Swedish turnips. The acre was

divided by a line running through the middle across the plats, the one end being devoted to cabbages, the other to turnips.

This acre had been for five years devoted to soil-test work, the crops in order of succession having been corn, potatoes, soy beans, grass and clover, and grass and clover. During this time the nothing plats have received no manure or fertilizer of any kind. The variety of cabbages raised was Fottler's Drumhead. The seed was planted in the field. The average yield of the nothing plats was at the rate of 2,470 pounds of hard and 7,190 pounds of soft cabbages per acre.

The average result of the application of phosphoric acid was an increase at the rate per acre: hard heads, 9,557.5 pounds; soft heads, 1,912.5 pounds, — a profit from the use of phosphate amounting to $23.08 per acre. The use of the phosphate without potash, however, had practically no effect upon the crop.

The average increase apparently due to the potash is at the rate per acre: hard heads, 10,147.5 pounds; while there is an average decrease in soft heads at the rate of 527.5 pounds per acre. The net average result of the use of potash is profit at the rate of $21.51 per acre. The potash, even without the phosphoric acid, produces a considerable increase, but produces two and one-half times as great an increase in combination with a phosphate.

The nitrogen is much less useful. The average is at the rate of 2,627.5 pounds increase in hard heads and 402.5 pounds decrease in soft heads, per acre. It produces the largest increase when used with phosphate. The net result of the use of nitrate of soda is a gain at the rate of $6.07 per acre.

The results are not as clear in their indications as could be wished, though they point to a close dependence of this crop upon both potash and phosphoric acid manuring. The experiment will be repeated when opportunity offers.

3. *Soil Test with Swedish Turnips.*

This crop, as stated above, occupied one-half of the acre on which the test with cabbages was carried out. The variety was Laing's Swedish turnip, sown June 13. The results show a close agreement with those obtained with the cabbages. The average of the nothing plats was at the rate of 10,250 pounds per acre.

The average result of the use of phosphoric acid (dissolved bone-black) was an increase at the rate of 6,308.5 pounds per acre. Similar averages for the potash (muriate) and nitrogen (nitrate of soda) were, respectively, 7,255 and 2,891.7 pounds. The net average profits are at the rates per acre: for the phosphoric acid, $9.42; for the potash, $11.35; and for the nitrate, $2.58.

Here, as with the cabbages, the combination of phosphoric acid and potash seems essential to large increase in the crop. The phosphoric acid without potash gives no increase; with potash alone, an increase at the rate of 11,700 pounds per acre. The potash alone gives an increase of but 400 pounds per acre, but with the phosphate it gives an increase of 13,633 pounds per acre.

The combination of phosphate and potash gives an increase at the rate of 12,100 pounds per acre, as compared with the nothing plats nearest to the one on which it was used.

4. *Soil Test with Soy Beans, Amherst, South Acre.*

This is the eighth season of soil-test work upon this acre. The beans, variety Medium Green, were sown May 19, in drills 2½ feet apart, requiring 25 pounds seed for the acre. The nothing plats produced an average of 350 pounds beans and 757½ pounds straw per acre.

Potash (muriate) appears to be the most useful element, giving an average increase per acre of 646⅔ pounds beans and 451⅔ pounds straw. The average increase per acre caused by phosphoric acid (dissolved bone-black) was 126⅔ pounds beans and 250 pounds straw. Similar average for nitrogen (nitrate of soda) was 13½ pounds beans and 116⅔ pounds

straw. Nitrogen produced a decrease, except when used with both phosphoric acid and potash.

In appearance the beans grown upon potash were larger and plumper than those grown upon either phosphoric acid or nitrogen.

Manuring the Corn Crop.

1. *Manure alone v. Manure and Potash.*

The past is the sixth year of continuous culture of corn upon the same acre of land for the purpose of testing the relative value of an application yearly of a small quantity of *manure* with *muriate of potash*, as compared with a larger application of *manure alone.* When manure alone was applied, it was put on at the rate of 6 cords per acre, being spread broadcast after ploughing, and harrowed in. The manure and potash similarly applied have been put on at the rate of 4 cords of the former and 160 pounds of muriate of potash for the latter.

The plats, four in number, contain one-quarter of an acre each. The results are shown below: —

Plat 1, manure, 8,115 pounds: stover, 1,600 pounds; ear corn, 1,530 pounds.

Plat 2, manure, 5,354 pounds; muriate of potash, 40 pounds: stover, 1,300 pounds; ear corn, 1,455 pounds.

Plat 3, manure, 8,981 pounds: stover, 1,255 pounds; ear corn, 1,450 pounds.

Plat 4, manure, 5,711 pounds; muriate of potash, 40 pounds: stover, 970 pounds; ear corn, 1,120 pounds.

In plats 3 and 4 the corn was planted in hills, while in 1 and 2 it was planted in drills. This no doubt accounts in a measure for the considerable difference in yield. The inferiority of the crop from plat 4 is due to the fact that, from force of circumstances, poorer manure was used upon it in 1895 than upon the other plats.

Averaging the results upon 1 and 3 and upon 2 and 4, we find the yields have been at the following rates per acre: —

With manure alone: stover, 5,710 pounds; grain, $73\frac{1}{4}$ bushels.

With manure and potash: stover, 4,540 pounds; grain, $64\frac{3}{8}$ bushels.

In no one of the six years during which this experiment has been continued has the crop raised on the combination of manure with potash equalled that raised on a larger quantity of manure alone; but the differences have been small, and in no case has the value of the excess in crop produced by the larger quantity of manure been sufficient to cover the excess in cost of the manure applied. The difference in crop is this year considerably larger than in any preceding year; and, as this difference has been quite steadily increasing, we are justified in concluding that the manure and potash in the quantities employed cannot fully take the place of the larger application of manure in continuous corn culture. It is true the crop where the manure and potash are employed is still an excellent one, averaging for the two plats at the rate of more than 63 bushels per acre. Continuous corn culture is not, however, the rule, nor indeed under most circumstances advisable, though often proved to be possible, at least for many years; and therefore this land has now been seeded to grass and clover, for the purpose of determining to what extent, if any, the introduction of these crops will enable the farmer under the given manuring to secure equal crops with both systems.

2. *Special Corn Fertilizer v. Fertilizer containing More Potash.*

This experiment in continuous corn culture was begun in 1891, and the present is, therefore, the sixth season. The object in view is a comparison of the results obtained with a fertilizer proportioned like the average of the "*special*" *corn fertilizers* found upon our markets in 1891 with those obtained with a fertilizer richer in potash but furnishing less nitrogen and phosphoric acid. The results in previous years have indicated the financial advantage to lie with the latter fertilizer.

Four plats of one-fourth of an acre each are devoted to this experiment, which are respectively numbered 1, 2, 3 and 4.

The materials applied to the several plats are shown below: —

FERTILIZERS.	Plats 1 and 3 (Pounds Each).	Plats 2 and 4 (Pounds Each).
Nitrate of soda,	20	18
Dried blood,	30	30
Dry ground fish,	30	20
Plain superphosphate,	226	120
Muriate of potash,	22.5	60
Cost of materials per plat,	$3 23	$3 10

The materials supplied to plats 1 and 3 would furnish per acre the quantities of nitrogen, phosphoric acid and potash found in 1,200 pounds of fertilizer having the average composition of the "special" corn fertilizers upon the market at the time the experiment was commenced, viz., 1891. The average price per plat for 300 pounds of such fertilizer (the amount needed per plat to equal the above materials) is about $5.25.

The yields the past year are shown below: —

Plat 1, "special" fertilizer: stover, 935 pounds; ear corn, 1,110 pounds.

Plat 2, fertilizer richer in potash: stover, 995 pounds; ear corn, 1,030 pounds.

Plat 3, "special" fertilizer: stover, 790 pounds; ear corn, 1,135 pounds.

Plat 4, fertilizer richer in potash: stover, 865 pounds; ear corn, 1,065 pounds.

Computed to the acre and the grain in bushels, the averages are: "special," stover, 3,450 pounds; grain, 56.1 bushels; fertilizer richer in potash, stover, 3,720 pounds; grain, 52.4 bushels. It will be noticed that the "special" fertilizer gives rather more grain and less stover than the fertilizer richer in potash. This result is in entire accord with the results of previous years, and the indications are strong, therefore, that our mixture "richer in potash" needs modification to make it equal in grain-producing power to the "special" fertilizer for *continuous corn culture.* It is

still my belief, however, that under ordinary farm conditions the "*fertilizer richer in potash*" would be found equal at least to the "special," for under such conditions grass and clover would alternate with the corn; the clover, judging from facts almost universally noticed, would thrive better where more potash had been used, and as a result the soil would be enriched in nitrogen, which would be favorable to the development of the succeeding corn crop. In all of our "soil-test" work the nitrogen has ranked next to the potash in benefit to this crop. With a view to testing the correctness of this conclusion, the land used for this experiment has now been seeded to grass and clover, and after two or three years will again be planted with corn.

The average crop raised on the "special" fertilizer this year is worth $0.83 more per acre than the average for the fertilizer richer in potash; the fertilizer materials used cost $0.52 more. There is no material difference, therefore, in the financial outcome of the two systems under the given conditions; but, as above pointed out, should the farmer purchase a manufactured "*special*" *corn fertilizer*, it would have cost him about $5.25 per plat, or $21 per acre, to procure equal amounts of the essential elements of plant food. Since the "*fertilizer richer in potash*" cost $3.10 per plat, or $12.40 per acre, while the crop was practically almost as valuable as that produced on the "special," it follows that here is a possible saving of almost $8 per acre in initial expenditure. It is true that the materials recommended require mixing, while the "special" fertilizer is already mixed. It is not true that the elements of plant food in the "special" are in better forms, or more available. In conclusion, however, it is but fair to state that the prices used in calculating the cost of the "*materials*" are cash prices, while the price of the "special" is determined in a measure by the fact that credit must often be given for such goods.

Hill v. Drill Culture for Corn.

In each of the two experiments above described one-half of each acre has each year been planted in drills and the other half in hills. Plats 1 and 2 in each case have been

planted in drills, and plats 3 and 4 in hills. The distance between the rows under both systems has been $3\frac{1}{2}$ feet. Under the "drill" system, the plants have been thinned to 1 foot; under the "hill" system, the hills are 3 feet apart and the plants are thinned to three in a hill. We thus have equal numbers of plants under the two systems. The results the past year average as follows: for the acre receiving manure, drill culture, at rate per acre, stover, 5,800 pounds; grain, $74\frac{5}{8}$ bushels; hill culture, at rate per acre, stover, 4,450 pounds; grain, 63 bushels; for the acre receiving fertilizer similar averages are, drill culture, stover, 3,630 pounds; grain, $53\frac{7}{8}$ bushels; hill culture, stover, 3,540 pounds; grain, $54\frac{5}{8}$ bushels. Averaging both experiments, we have, for drill culture, stover, 4,715 pounds; grain, $64\frac{1}{4}$ bushels; for hill culture, stover, 3,995 pounds; grain, $58.\frac{4}{5}$ bushels.

Green Manuring in Continuous Corn Culture.

White mustard as a crop for green manuring and nitrogen conservation was sown on one-half the acre where *manure alone* has been under comparison with *manure and potash* in each of the years from 1892 to 1894 inclusive, the seed being scattered in the standing corn late in July in each year. The growth varied greatly from year to year, but the practice proved beneficial. In 1895 the increase in the corn crop apparently due to the culture of the mustard amounted to: stover, 452 pounds; grain, 5.4 bushels. In July, 1895, the mustard was sown only on one-quarter of the acre, and, because of a very dry and hot autumn, the growth was light. The crop on this quarter this year shows an increase as compared with the quarter not so treated of: stover, 680 pounds; grain, 3 bushels, per acre.

The other plat, which had been sown with mustard in preceding years, was in 1895 sown with rye on September 5, at the rate of 3 bushels per acre. The growth was good, and the rye, when ploughed in on May 11, was 18 inches tall. The apparent result of this treatment is a decrease in crop at the rate per acre: stover, 700 pounds; grain, $4\frac{3}{4}$ bushels. It seems impossible to believe that the effect of this treatment can be permanently injurious. The decrease

in yield this year may be due to the fact that considerable available plant food which was locked up in the rye has not yet by the decay of the vegetable matter of this crop become again available. If this be the true explanation, then in the next year the beneficial effect of the green manuring should become apparent.

On the acre where "*special*" *corn fertilizer* has been under comparison with *fertilizer richer in potash* some crop of *the clover family* has been sown in the standing corn each year since 1893; but the crops themselves have been under trial, and have not shown themselves fitted for the purpose in view. Thus, in 1893 and 1894 *crimson clover* was tried, but each following spring the crop was killed and the results were unimportant. In July, 1895, *sweet clover* (*Melilotus alba*) was sown upon one quarter and common *red clover* upon another. The *sweet clover* was badly thrown out by the frost, and hardly a plant survived; while the red clover starts too late in spring to have made much growth before it must be turned in. The results are unimportant in both cases, though the crop this year is somewhat greater where the red clover was sown, viz., at the rate of 55.25 bushels per acre, against 52.75 bushels where no clover was sown.

Variety Tests.

1. *Potatoes.*

In the spring of 1895 we procured as far as possible seed of all prominent and new varieties of potatoes, necessarily from widely scattered and very different sources. This seed was planted for the purpose of raising under like conditions a stock of the different sorts, which, having been produced under identical conditions and in every respect handled alike, it was thought would be suited for a comparative test of varieties. Sixty varieties, the seed of which (in every instance save one) was raised upon our own grounds last season, have been made the subject of such a comparative trial this year. The variety the seed of which was from another source is Carman No. 1. Our seed of this sort raised last year was accidentally destroyed, and, as the variety is a prominent one, it was thought best to pro-

cure enough for this trial from a prominent grower in this State, Dr. Jabez Fisher of Fitchburg. Of most varieties we planted 2 rows, each 209 feet long; but in some cases, where the seed was insufficient, only 1 row was planted.

The seed was washed and treated with a solution (2 ounces to 15 gallons of water) of corrosive sublimate on April 13. The tubers were then placed on the earth in a cold frame without glass, where they were allowed to remain until May 1, when they were cut into pieces having two eyes each, and of as nearly equal size as possible. At this time the tubers had sent out numerous thick green sprouts, which were perhaps about one-eighth to one-fourth of an inch in length. The tubers when cut were rolled in plaster. They were planted on May 5 and 6, the pieces being placed just 1 foot apart in the rows. In those cases where the supply of seed was insufficient to plant a full row, the row was filled out with seed of the Beauty of Hebron, that there might be no vacancies.

The treatment of the seed with corrosive sublimate solution entirely prevented scab, and the system followed in sprouting the tubers was eminently satisfactory. It should perhaps be stated that when the sun shone hot the tubers were covered with a sheet of thin white cotton cloth. But for this protection it is to be feared that in a cold frame they might get overheated on excessively hot days.

The land where the test was made was last year in millet and soy beans, the rows this year running across the divisions of last season, so that each row of this year is exactly comparable with every other. The soil is a medium loam, well adapted to the potato. Fertilizers only were applied, and at the following rates per acre: nitrate of soda, 240 pounds; dried blood, 100 pounds; tankage, 240 pounds; plain superphosphate, 400 pounds, and high-grade sulphate of potash, 250 pounds. These materials were mixed and strewn in the furrows before the seed was dropped. All needful operations were seasonably and thoroughly carried out. The season was on the whole favorable, so that the crop suffered from no unusual conditions. Careful notes were taken throughout the season, covering all peculiarities in growth and development, time

of blossoming, etc. All varieties suffered somewhat from early blight (*Macrosporium solani*). This was first discovered on 1 variety on July 18. By the 22d it could be detected on 26 other varieties, and by August 3 all except 1 were affected. As early as August 8 the vines of 17 varieties were entirely dead. Between the 8th and 20th the vines of 26 other varieties died, while by August 29 all were dead.

An attempt to prevent this blight by repeated applications of "Fungiroid" was an entire failure. It will be noticed that considerable differences in degree of susceptibility to "blight" showed themselves. Until the varieties have been further tested, however, it is not deemed advisable to publish the details.

The crop was harvested in part on September 10–12, and the balance September 24–25. There was no rot, and the tubers were for the most part smooth and handsome.

The yield has been in every case corrected to 207 hills or sets, so that the results are strictly comparable. The area occupied by this number of hills is almost exactly one-seventieth part of an acre; so that, to bring out the significance of the differences more clearly, I have multiplied the results by seventy, and converted into bushels, thus showing the *rate per acre* yielded by the different sorts.

The varieties are reported in alphabetical order, and for each the tubers are divided into the customary classes, viz., merchantable and small.

Varieties of Potatoes, Yield per Acre (Bushels).

NAME.	Merchantable Tubers.	Small Tubers.
Alexander's Prolific,	123.3	14.0
Alliance,	285.8	42.0
Beauty of Hebron,	275.9	18.7
Bill Nye,	226.3	25.7
Bliss's Triumph,	276.5	25.7
Burbank's Seedling,	207.7	23.3
Burpee's Extra Early,	208.8	49.0
Carman No. 1,	355.3	28.6
Carman No. 3,	199.5	16.9
Chance,	201.8	30.3

Varieties of Potatoes, Yield per Acre (Bushels) — Concluded.

NAME.	Merchantable Tubers.	Small Tubers.
Clarke No. 1,	255.5	26.8
Columbus,	265.4	33.3
Crown Jewel,	169.1	29.2
Dakota Red,	283.5	28.0
Delaware,	235.7	22.2
Dutton's Seedling,	304.5	19.8
Early Essex,	162.2	35.0
Early Harvest,	234.5	44.3
Early Maine,	305.1	35.6
Early Market,	229.9	28.6
Early May,	232.8	22.2
Early Northern,	266.0	42.0
Early Ohio,	159.8	17.5
Early Ohio, Jr.,	232.8	25.1
Early Rose,	292.8	21.0
Early Sunrise,	268.3	32.7
Empire State,	271.3	12.3
Fillbasket,	336.0	24.5
Freeman's,	203.6	30.9
Hampden Beauty,	232.8	27.4
Hampden Chief,	187.8	4.7
Henderson's Early Puritan,	250.8	34.4
Irish Daisy,	172.1	59.1
Late Puritan,	277.1	28.0
Maggie Murphy,	227.5	28.0
Merriman,	266.6	44.9
Monroe Co. Prize,	240.3	31.5
Monroe Co. Seedling,	248.5	21.0
New Ideal,	204.2	8.2
New Queen,	255.5	49.2
New Satisfaction,	306.8	25.7
Onward,	200.7	26.3
Polaris,	149.3	31.5
Pride of the West,	243.8	26.8
Quick Return,	239.8	29.8
Restaurant,	259.0	21.6
Rochester Rose,	272.4	31.5
Rural New Yorker No. 2,	218.8	22.2
Sir William,	282.9	19.8
Six Weeks,	141.8	20.4
Snow Flake,	169.8	32.1
State of Maine,	252.6	34.4
Summit,	246.8	28.6
Sunlit Star,	232.8	41.4
Thorburn,	255.5	31.5
Vanguard,	255.5	30.9
White Elephant,	295.8	23.9
White Star,	235.1	28.0
Woodbury's White,	289.3	26.3
World's Fair,	145.8	26.8

A study of these figures reveals the fact that there are wide differences in yield; but it is noteworthy that the yield of such old standard sorts as the Early Rose and Beauty of Hebron stands far above the average. The yield of the Early Rose is exceeded by but 6 varieties, viz., Carman No. 1, Fillbasket, New Satisfaction, Early Maine, Dutton's Seedling and White Elephant, named in the order of superiority. In addition to these, 6 other varieties, viz., Woodbury's White, Alliance, Dakota Red, Sir William, Late Puritan and Bliss's Triumph slightly exceed the yield of the Beauty of Hebron. In justice to this variety, it is proper to state that it occupied an outside row adjoining land planted to millet, rape and mustard, and was undoubtedly somewhat injured by its proximity to these, as their growth was exceptionally rank. It may well be doubted whether, under precisely equal conditions, the Beauty of Hebron would have been exceeded in yield by a larger number of varieties than was the Early Rose.

The varieties especially noteworthy for large yield in the order of actual production of merchantable tubers, then, with rates per acre in bushels, are the following: Carman No. 1, 355.3; Fillbasket, 336; New Satisfaction, 306.8; Early Maine, 305.1; Dutton's Seedling, 304.5; White Elephant, 295.8; Early Rose, 292.8; Woodbury's White, 289.3; Alliance, 285.8; Dakota Red, 283.5; Sir William, 282.9; Late Puritan, 277.1; Bliss's Triumph, 276.5; and Beauty of Hebron, 275.9. These varieties will all be tested as to eating and keeping qualities.

Seed of 21 other varieties has this season been procured in small amounts from various sources, and the tubers produced from these will be preserved for comparison another season. Ten of these have given a yield at the rate of more than 300 bushels of merchantable tubers per acre, and are therefore very promising.

2. *Corn.*

Sixty-seven varieties of field corn have been under trial upon a small scale, for the purpose of preliminary observations as to merits and adaptability to different uses; 21 of these were Flint and 46 Dent varieties. Three rows (each

75 feet long) of each variety, with one or two exceptions where not sufficient seed could be obtained, were planted. The trial has involved a large expenditure of time and attention. Notes have been taken from day to day, covering such points as germination, dates of tasselling and silking, height, relative leafiness, time of cutting, etc. The autumn was exceptionally unfavorable to curing of the corn crop; and hence, though an exact record of the weights of product (sound hard ears, soft ears and stover) has been made, it is of less value as a basis for comparative judgment than would ordinarily be the case. Particularly is this true in relation to the stover of the later Dent varieties.

The field used for this trial was in corn last year. The soil is a medium heavy loam, and quite even in quality throughout. *A fertilizer supplying, per acre, nitrate of soda, 72 pounds; dried blood, 120 pounds; dry ground fish, 80 pounds; plain superphosphates, 480 pounds; and muriate of potash, 240 pounds, was applied broadcast after ploughing, and harrowed in.* The rows were uniformly spaced throughout the field, viz., 3½ feet apart. The corn was so planted in checks that when thinned it stood, single plants, at the following intervals in the row: *for all Flint varieties*, 8 inches; for the earlier Dents, 10 inches; and for the later Dents, 12 inches.

Without going into much detail, I have to report further concerning this trial: —

1. That the following pairs of varieties appear to be nearly if not quite identical: —

Champion White Pearl and White Pearl.
Buckbee's No. 7 and Colossal.
White Cap Dent and White Cap Yellow Dent.
Sanford and White Flint.
Rideout and Longfellow.
Dibble's Early Mammoth and Houghton's Silver White Flint.

2. The yield of ear corn all or nearly all of which was sound and well cured varied: for the Flint varieties, between 79 and 130 pounds; for the Dent varieties, between 78 and 144 pounds.

3. Seven out of the 21 Flints gave a yield of 120 pounds* or over; 13 of the 46 Dents gave a similar yield, but with a larger proportion of imperfectly cured ears; 33 per cent. of the Flints and 28 per cent. of the Dents, therefore, come into this class.

4. The yield of stover varied: for the Flint corns, between 104 and 245 pounds; for the Dent corns, between 94 and 451 pounds. Some of the Dents giving high yields of stover were far from perfectly cured.

5. The order of rank in yield of ears of the best 5 Flint varieties was as follows: White Flint, Sanford, Compton's Early, Giant Long White and Longfellow.

6. The best 5 Dent varieties in order of ear production are: Yellow Rose, Mastodon, Reed's Yellow Dent, New Golden Triumph and Leaming.

7. Sibley's Pride of the North, very thoroughly matured, ranks ninth in production of ears, and is undoubtedly one of the best Dent varieties for grain production.

8. The following varieties appear to be unsuited to our locality, on account of being too late: Brazilian, Farmer's Favorite, Queen of the Prairie, Golden Beauty, Golden Dent, Legal Tender, Mammoth White Surprise and Dr. Woodhull.

9. Three other varieties are certainly too late for culture as grain crops, but appear to promise well for the silo, viz., New Golden Triumph, Hickory King and Mastodon.

3. *Clovers.*

Four varieties of clover have been given a thorough comparative trial, viz., mammoth (*Trifolium medium*), common red (*T. pratense*), alsike (*T. hybridum*) and crimson (*T. incarnatum*). The soil of Field B is a medium heavy loam, but thoroughly drained. For some twelve years it has been manured only with ground steamed bone and potash salts. The plats are one-tenth of an acre each in size. Every plat is manured yearly with ground bone, at the rate of 600 pounds to the acre; one-half of these plats receive yearly an

* A yield of 120 pounds corresponds to a product of 83⅓ bushels shelled grain per acre.

application of muriate of potash at the rate of 200 pounds per acre, and the other half receive the same quantity of high-grade sulphate of potash. The land was occupied by grain crops cut for fodder in 1895. Soon after the fodder was removed the land was ploughed, and the seed was sown on August 1. Of the mammoth and common red clovers, 3 pounds of seed per plat were sown; of the alsike clover, $2\frac{1}{2}$ pounds; and of the crimson clover, 4 pounds. The seed of all varieties started promptly and well and all varieties went into the winter in excellent condition.

The crimson clover early in March appeared to be in good condition, but during the latter weeks of March it gradually weakened and died. By the first of April there was scarcely a plant in the field alive. This species appears unable to endure our average spring weather. The crimson clover plats were accordingly ploughed in April and resown, $5\frac{1}{2}$ pounds of seed per plat being used, on April 24. The seed started quickly, and, as will be seen by the tables which follow, this variety gave one good crop, at the rate of nearly 3 tons to the acre on the best plat. This clover was cut on July 17, at which time it was in *mid-bloom*. Notwithstanding frequent showers soon after, the stubble failed to start, and in a few weeks was almost entirely dead, at which time the plats were reploughed. It will undoubtedly be found necessary to cut this variety just as it begins to bloom, in order to insure later cuttings.

The very few plants in this field (as well as those from another with lighter soil) which survived the early spring weather were taken up and replanted, in order to secure seed, in the hope that we may in time by a continuance of this process of selection produce a strain or variety of this species which will prove hardy with us.

For culture as an annual it seems unlikely that crimson clover will prove of much importance, as in that case it would not give earlier fodder than the other clovers. Could it be cultivated as a winter annual, on the contrary, it must take an important place as a crop both for fodder and for green manuring, — for fodder chiefly, because it would be ready to cut at so early a date, and for green manuring, since it grows so rapidly.

Mammoth Clover. — This variety was cut on June 23, at which time it was not in full bloom. It was thought best to harvest, as it was lodging badly. On August 10 it was cut for the second time. It did not make sufficient growth thereafter to warrant cutting again. Though cut, therefore, but twice, while the common red clover was cut three times, the mammoth clover produced slightly more hay than the former. The two crops make a yield at the rate of rather more than 4½ tons per acre. This hay is not objectionably coarse, or, rather, not much more so than that of the common red variety. This mammoth clover, as will be seen by reference to the table below showing composition of the crops, is not inferior in nutritive value to the common. The mammoth is to be especially recommended for sowing in mixtures of which timothy is a prominent part, as it matures more nearly with this grass than does the common red.

Common red clover calls for little special comment. Each of the three cuttings was made when the crop was a little past full bloom; the dates, June 19, July 28 and October 9. The average total yield of the plats (one-tenth of an acre each) is at the rate of a little more than 4¼ tons per acre. The composition of this variety will be found in the table which follows those showing yield and dry matter.

Alsike clover gave two excellent crops, cut respectively on June 19 and August 10: but, while the sod of both the mammoth and common red on November 3 appeared to be in excellent condition, the sod of this variety shows signs of weakness. Weeds are coming in to a considerable extent, principally sorrel. The table of composition shows this clover to be somewhat richer in nitrogenous nutrients (protein) than either of the others. This difference in its favor is in part offset by lower percentages of fat and extract, and it is doubtful whether the hay of this variety is worth more for food than that of either of the others. Alsike clover is especially recommended for soils which are rather too moist for the common red variety.

FIELD B. — *Trial of Clovers (Bone at Rate of 600 Pounds per Acre to All Plats).*

	Mammoth Clover.		Common Red Clover.		Alsike Clover.		Crimson Clover.	
	Plat 13. Muriate of Potash.	Plat 14. Sulphate of Potash.	Plat 15. Muriate of Potash.	Plat 16. Sulphate of Potash.	Plat 17. Muriate of Potash.	Plat 18. Sulphate of Potash.	Plat 19. Muriate of Potash.	Plat 20. Sulphate of Potash.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
First crop,	615	650	455	455	620	455	575	595
Second crop,	295	305	276	294	325	200	-	-
Third crop,	-	-	120	120	-	-	-	-
Total crop,	910	955	851	869	945	655	575	595

FIELD B. — *Clovers (Dry Matter in the Crops).*

	Mammoth Clover.				Common Red Clover.				Alsike Clover.				Crimson Clover.			
	Plat 13.		Plat 14.		Plat 15.		Plat 16.		Plat 17.		Plat 18.		Plat 19.		Plat 20.	
	Per Cent.	Pounds.	Per Cent.	Pounds.	Per Cent.	Pounds.	Per Cent.	Pounds.	Per Cent	Pounds.	Per Cent.	Pounds.	Per Cent.	Pounds.	Per Cent.	Pounds.
First crop,	83.19	511.6	83.32	541.6	82.1	373.5	85.7	390.1	74.0	458.5	78.4	356.5	73.6	422.9	68.4	406.9
Second crop,	83.06	245.1	83.52	254.7	77.3	213.2	78.4	230.5	84.6	274.7	81.0	162.0	-	-	-	-
Third crop,	-	-	-	-	83.3	99.9	83.3	99.9	-	-	-	-	-	-	-	-
Total dry matter,	756.7		796.3		686.6		720.5		733.2		518.5		422.9		406.9	

Composition of Clover Hay.

POTASH SALT.	Mammoth.		Common Red.		Alsike.	
	Muriate (Per Cent.).	Sulphate (Per Cent.).	Muriate (Per Cent.).	Sulphate (Per Cent.).	Muriate (Per Cent.).	Sulphate (Per Cent.).
Water,	16.81	16.88	17.92	14.26	26.05	21.64
Dry matter,	83.19	83.32	82.08	85.74	73.95	78.36
	100.00	100.00	100.00	100.00	100.00	100.00
Dry matter contains: —						
Crude ash,	9.97	8.96	8.79	8.22	10.67	9.77
Crude cellulose,	30.35	30.40	31.46	30.24	30.32	30.23
Crude fat,	2.00	2.18	2.66	3.15	2.07	2.08
Crude protein,	14.65	14.86	13.34	12.61	16.48	15.82
Nitrogen-free extract matter,	43.03	43.60	43.75	45.78	40.46	42.10

Sulphate v. Muriate of Potash for Clovers. — This experiment with clovers was so carried out as to allow a careful comparison between the sulphate and the muriate as sources of potash for this crop, as well as the comparisons between varieties. A study of the figures giving yields shows that there seems to be no clearly defined difference in the effect of the two salts upon the total product. It is true that in the case of the alsike clover the muriate plat produced much the larger crop; but, since this was not the case with either of the other varieties, we are not justified in concluding that this difference is a direct consequence of the different manuring.

A study of the figures showing the composition of the crops from the several plats, however, reveals the fact that in every instance the percentage of nitrogen-free extract is greater in the hay raised on the sulphate of potash. It is true that the difference is not large, though in the case of the red clover it is sufficient to make a difference of rather over 140 pounds of this valuable class of nutrients in the product of one acre. It seems probable that this difference is due to the action of the chlorine of the muriate of potash in decreasing the formation of starch, — an effect which has often been noticed with the potato. Since, then, starch is

one of the most valuable constituents of foods, it follows that the sulphate is to be preferred to the muriate of potash, if it can be obtained at the same price. This, however, has not thus far been the case. At prevailing prices, the muriate would seem likely to be the more profitably employed.

4. *Millets for Seed.*

The three species of Japanese millet reported in previous years have been again cultivated for seed. The product has been at the following rates per acre: barn-yard millet (*Panicum crus-galli*), straw, 6,554 pounds, seed, 57 bushels; Japanese panicle millet (*Panicum miliaceum*), straw, 5,514 pounds, seed, 26 bushels; common Japanese millet (*Panicum italicum*), straw, 5,017 pounds, seed, 53.3 bushels. The weights per bushel of the seed are respectively 35, 54 and 42 pounds. Owing to unfavorable weather, a large amount of the seed of the barn-yard millet wasted in the field, hence the yield appears smaller than it actually was.

5. *Millets for Fodder.*

(*a*) *First Experiment.* — Our three species of Japanese millets, viz., the "barn-yard," the "panicle" and the "common," have been carefully compared with each other and with Hungarian grass as fodder crops upon a somewhat extensive scale. Nearly one-half an acre of the barn-yard variety and one-third of an acre each of the others were sown. The soil was a rather heavy loam, which for several years has been manured only with fertilizers. On a part of each plat the fertilizers applied were bone meal, lime and double sulphate of potash and magnesia; on the balance of each, nitrate of soda, Thomas phosphatic slag and the double sulphate were applied. To Dr. Goessmann is left the discussion of the results of the two systems of manuring, as they were planned by him. We have here to do only with the comparison of the varieties under trial. Suffice it to say that the fertilizers were applied in only moderate amounts, and that they were spread after ploughing, and harrowed in. All varieties were sown on June 2, the seed covered with Breed's weeder and the land then rolled.

The following table shows the amount of seed sown, the date of cutting and the yield of well-cured hay. For convenience of comparison, the yield of the "barn-yard" variety is given for the same area as the others: —

Varieties of Millet (One-third Acre Each).

VARIETY.	Quantity of Seed sown (Quarts).	Date of Cutting.	Yield of Hay (Pounds).
Hungarian grass, ...	$6\frac{1}{2}$	Aug. 15,	1,730
Japanese common millet, . . .	8	Aug. 26,	2,025
Japanese panicle millet, . . .	8	Aug. 15,	2,410
Japanese barn-yard millet, . .	$4\frac{1}{3}$	Aug. 15,	2,603

The fact must be stated that the quantity of seed of the "barn-yard" variety proved to have been rather too great for a season so favorable for rank growth as was the last. The crop of this variety lodged badly, and was therefore cut rather before it would otherwise have been. It was the intention to cut each variety when the seed of the plants on the earliest portion of the plat was well formed, but before it began to harden; and this was done except in the case of the barn-yard variety, which, as before stated, was cut a little before this stage was reached. The several varieties yielded, as determined by calculation from the results given in the above table, at the following rates per acre of well-cured hay: Japanese barn-yard millet, 7,830 pounds; Japanese panicle millet, 7,230 pounds; Japanese common millet, 6,075 pounds; and Hungarian grass, 5,190 pounds.

(*b*) *Second Experiment.* — Seventeen varieties of millet, including the 4 above discussed, were given a trial upon a smaller scale, upon similar soil and under similar conditions to those just described. The plats in this experiment were ten rods long and one rod wide, containing, therefore, one-sixteenth of an acre each. The results are shown in the table which follows: —

Millets, Variety Tests (Plats One-sixteenth Acre Each).

	Quantity of Seed (Quarts).	Height of Plants (Inches).	Date of Cutting.	Yield of Hay (Pounds).
Canary bird seed,* . .	2	30	Aug. 25,	295
Early Harvest,. . .	2	36	Aug. 4,	325
Mukodamaski (Japanese),	2	42	Sept. 8,	540
Golden, . .	2	54	Sept. 8,	610
Golden Wonder, .	2	48	Aug. 13,	480
Hokkaido (Japanese), .	2	47	Aug. 25,	430
Japanese common, . .	2	48	Aug. 25,	475
Hungarian, .	2	39	Aug. 13,	550
Japanese white panicle, .	1½	78	Aug. 31,	840
Chinese, ...	1½	51	Aug. 4,	460
Common broom corn, .	1½	40	July 28,	450
White French, . . .	1½	48	July 31,	310
Red French, ...	1½	34	July 28,	300
Hog,.	1½	37	July 28,	370
California, ...	1½	37	July 28,	370
Japanese panicle, . .	1½	55	Aug. 15,	490
Japanese barn-yard, .	1	66	Aug. 13,	620

* In this table the names under which the varieties were advertised are used in the case of all purchased sorts. The Japanese varieties are of our own importation or production.

The varieties especially noteworthy for large production are the Japanese white panicle and the Japanese barn-yard, the latter not doing its best either in this trial or the other, on account of having been sown too thick. In estimating the significance of these results, this fact must be kept in mind. It is further important to state that the barn-yard variety is far less harsh and woody than any of the other large-growing varieties of millet. Its extreme succulence, however, makes it rather difficult to cure. We have had most success in handling it as clover is usually handled by the best farmers, viz., by curing mostly in the cock. It is our intention to publish analyses of these millets in a later report or bulletin.

Miscellaneous Crops.

A considerable number of miscellaneous crops have been under trial upon a small scale, or have been cultivated for illustrative purposes. Under this class may be included 37 species of grasses; 22 varieties of millet for seed; 26 species and varieties of leguminous fodder or green manur-

ing crops; 7 varieties of oats; several varieties of sorghum recommended for fodder, — saccaline, iris, beggar weed and cystisus, all sent in for trial as fodder crops; Ankee grass and 2 varieties of sugar beets. Many of these require no especial notice, while most of the others can be sufficiently discussed in a few words.

The grasses include a considerable number of species, received through the kindness of Professor Fletcher of the Ontario Agricultural College, which are as yet entirely unknown to the general cultivator. Several among them are indigenous to America, and appear to possess qualities which fit them in an especial degree for our soil, climate and conditions, and must make them of great value in our agriculture. The seeds of all these grasses were sown last spring, and it therefore follows that they have not yet had a trial sufficiently long to warrant definite conclusions. Among those species, however, which, so far as can be judged from one season's growth, appear to be expressly promising, are the following: *Bromus schradeii*, *Bromus ciliatus*, *Agropyrum tenerum* and *Avena flavescens vera*. Seven indigenous species from seed collected in Amherst and vicinity are under trial, and two species were sent for trial by the United States Department of Agriculture. One of these, *Eragrostis New Mexicana*, appears promising; the other, *Elensine Egyptiaca*, gave one good cutting, but failed to start thereafter. If an annual, as this behavior indicates, it can hardly prove important.

The Millets. — Among the 22 varieties included in this trial are most of those cultivated as fodder crops, besides a few others which were of especial interest. In this trial all varieties were allowed to ripen seed. As it was, however, found impossible to prevent the birds from taking some of the seed, — a serious matter, where the quantities are small, — it is not deemed important to publish the figures showing yields.

It has been decided, after the experience of two years in cultivating these varieties both for fodder and for seed, *that there is no appreciable difference between the varieties sold by various seedsmen under the following names: White French, Chinese, broom corn and California.* This variety, as well

as the French, red French and hog millets, are all apparently of the same species as the Japanese panicle millet, viz., *Panicum miliaceum*, and are all much inferior to the Japanese in productive capacity, and inferior, I believe, also, to Hungarian grass.

Leguminous Fodder and Green Manuring Crops.

Most of the species and varieties, 26 in number, coming under this class, have been named, described and commented upon in previous reports, and require no further mention at this time. Of a few it is necessary to speak briefly.

1. *Flat Pea* (*Lathyrus sylvestris*). — Of all the crops which have been urged upon the attention of the American farming public in recent years, few have been so highly praised as this. I am compelled to conclude, after three years' trial, and in view also of the experience of others, that it is not a crop which can prove valuable among us. The principal points against it are the following: —

(*a*) The seed germinates with extreme slowness and uncertainty, making this a difficult and expensive crop to start. It would hardly be possible to stock a field with it, except by starting the plants in a bed and then transplanting to the field.

(*b*) The plants are not perfectly hardy under average conditions.

(*c*) The plants in growing sprawl over the ground in such a manner as to make this a difficult crop to cut.

(*d*) The forage is not relished by cattle. This statement is based largely upon distinguished German authority.*

In conclusion, I may state that this crop does not appear to have made any important place for itself in the land of its origin, Germany.

2. "*Sweet Clover*" (*Melilotus alba*). — Two plats in Field B, each of one-tenth of an acre, were sown with this clover, as it was thought possible that it might prove useful for the silo or for green manuring. These plats are designated by numbers 10 and 11. Both received ground and steamed bone meal at the rate of 600 pounds per acre;

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* Dr. Max Maercker and Dr. Julius Kuehn.

Plat 10, muriate of potash; and Plat 11, high-grade sulphate of potash, in both cases at the rate of 200 pounds per acre. The seed was sown at the rate of 3 pounds per plat. The plants were badly thrown out of the ground during the winter, but most of them survived. The growth, however, was poor, and both were cut June 19, yielding: Plat 11, 200 pounds; Plat 12, 285 pounds, green weight.

It was noticed that isolated plants or clumps of plants while growing had a much deeper shade of green, and were in many instances three times the average height of the other plants in the field. Examination revealed the fact that in every instance the roots of these plants were thickly set with the nodules characteristic of the Leguminosæ, while such nodules were either entirely or almost entirely absent from the roots of the feebler plants, which class included a large majority of those in the plats. It is believed that this difference accounts for the wide variation in the different plants. These nodules are due to the development upon the roots of specific bacteria (microscopic fungi). These bacteria must develop, like other plants, from seed; and this seed, when the culture of a new crop of this class is first begun in a given locality, is not present as a rule in such quantity as to insure a full development of the nodules. Such as do develop must come from spores which adhere to the seed of the new crop. In the case of a second or later crop the spores are more abundant, for, as is often the case with weed seeds, the few developed the first year, remaining in the soil with the roots of the crop, retain their vitality, and accordingly the crop does better when grown a second or third time than at first, because the more abundant spores cause a more abundant development of root nodules upon which the assimilation of free atmospheric nitrogen depends.

In this case sweet clover had never been grown upon these plats before; hence, as there were probably no spores in the soil, and nodules could come only from the few spores which happened to adhere to the seed sown, there were in the aggregate but few and the crop did poorly. The plats have been sown again with the same crop, in the expectation that in the second year of its culture it will do

better. The probability that this will be the case should never be lost sight of when new leguminous crops are under trial.

3. *The Horse Bean* (*Vicia faba*). — This crop, so highly prized by Professor Robertson of Ontario, has been given a rather more extensive trial than most of the crops in this class during each of the last two years. It does not commend itself to my judgment as a fodder crop, for which it is recommended. It is subject to a blight, which often seriously injures it; it sets comparatively little seed, most of the blossoms blighting; and in yield it does not equal other leguminous crops which are more easily cultivated.

4. *Field Peas.* — During the past season we have tried three new varieties of field peas from Canada, all of which appear to be excellent sorts for field culture with oats or barley as fodder crops. There does not appear to be a very wide difference between the three in productive capacity. All were remarkably free from mildew. The table below gives all information necessary for a comparative estimate of these varieties: —

Field Peas (2 Rows, Each 70 Feet Long).

	English Gray.	Canada Beauty.	Prussian Blue.
	Pounds.	Pounds.	Pounds.
Total yield, pods filled but vines still green,	165	200	205
	Per Cent.	Per Cent.	Per Cent.
Dry matter,	14.77	18.28	18.06
Water,	85.23	81.72	81.94
	100.00	100.00	100.00
Dry matter contains: —			
Crude ash,	9.56	7.80	–
Crude cellulose,	30.23	28.99	–
Crude fat,	3.16	2.74	–
Crude protein,	20.65	16.14	–
Nitrogen-free extract,	36.40	44.33	–
	100.00	100.00	–

It is noticeable that the first variety is considerably richer in protein than the others; but, as the yield is so much smaller, either of the latter would seem to be preferable as fodder crops. They not only yield more heavily, but the fodder contains a considerably larger percentage of dry matter, which gives them greater food value. It might be thought that the Canada Beauty and Prussian Blue must have been more mature than the others, but this is not believed to have been the case. The effort was to harvest each in the same stage of maturity. Moreover, all were planted on the same date, May 2, and they were harvested as follows: English Gray, July 11; Canada Beauty, July 14; and Prussian Blue, July 2.

Oats. — Five varieties of *common oats* were tried upon a small scale, chiefly with a view to determining whether a variety could be found capable, under our peculiar climatic and soil conditions, of resisting rust. The attempt was a failure so far as this particular object is concerned, as all varieties rusted, and apparently to practically the same extent. The crop, however, was a fairly good one. The area occupied by each variety was 7 by 85 feet (one seventy-third of an acre). The yield is shown below: —

Varieties of Oats (One Seventy-third Acre Each).

	Straw (Pounds).	Grain (Pounds).	Weight per Bushel (Pounds).
Siberian,	57	30	32
Lincoln,	52	34	31
Black Beauty,	66	35	29½
New Illinois,	59	32	30½
White Poland,	52	27	33

A yield of 31 pounds is almost exactly at the rate of 70 bushels of 32 pounds each per acre.

Winter Oats. — Two varieties of winter oats have been tried during the past year. The seed of one sort was obtained from Dover, Del., of the other from Charlottesville, Va. In both of these States winter oats are considerably cultivated, and, as the impression there seemed to be that

these oats are quite hardy, it was decided to try them. We were also invited by Peter Henderson & Co. to make such a trial. One plat of one-tenth of an acre in rather heavy but well-drained loam and another of about three-eighths of an acre in medium loam were selected for the experiment. The seed was sown in drills about the last of September, and the oats had made a good start before cold weather. *Not a single plant survived the winter in either plat.*

Sorghum Varieties. — Several varieties of reputed fodder plants belonging to the genus *Sorghum* have been under trial in a small way during each of the last few years, usually at the suggestion of the United States Department of Agriculture. It is believed by some of the officers of this department that plants of this class, having greater capacity to resist drought than many others, will prove valuable fodder plants; and this opinion is seemingly justified by the results of trials in some of the western States. In Kansas, indeed, very favorable results have been obtained with some of them as grain crops. Such of these crops as have been tried here have always been put in warm, well-drained soil, but they have in no instance equalled Indian corn as fodder crops. Those tried this year are the following: "Jerusalem corn," "Red Kaffir corn," "White Kaffir corn" and "Millo maize." "Teosinte," although not a sorghum, can be considered with them. All of these grow very slowly at first, which increases the cost of culture largely, as compared with corn. None of them have ripened seed with us. *For the various reasons above stated, I do not regard any of these crops as likely to prove valuable for Massachusetts farmers.*

Saccaline. — Seed obtained in 1895 was started in a bed in the open air, and in midsummer plants were set in two plats, one in light sandy soil, the other in a heavy moist soil. The plants in the latter grew vigorously until late fall, those in the sandy soil but feebly. During the winter about 75 per cent. of the plants in both plats were killed. A similar proportion of plants temporarily set in a bed in medium loam died during the winter. Such plants as survived the winter in the moist soil made a very early start in the spring, but were entirely destroyed by later frosts. I judge that the plant is far from being sufficiently

hardy for our climate. Moreover, it is not much relished by stock unless cut very young. Further, it should be remembered, by any one trying it in a locality where it thrives, that it spreads rapidly by means of underground stems, and that it is extremely difficult to eradicate when once it has gained possession of the ground.

Iris pabularia. — Seeds were sent for trial by J. M. Thorburn & Co. of New York in 1895, the statement being made that it might prove valuable as a fodder crop. Germination was slow, the plants grew but feebly and during last winter all were killed.

Cystisus proliferus albus. — Seeds were received for trial of this plant as a fodder crop in the spring of 1895. Germination was imperfect, the plants did not make much growth and all died during last winter.

Florida Beggar Weed (*Desmodium tortuosum*). — Seeds sent for trial as a possibly valuable fodder crop were sown May 4. The plants grew to be about 3 feet tall, with numerous branches and leaves, which are eaten by stock. The main stem is hard and woody. The amount of fodder produced does not equal that produced by the soya bean in the same time. The plants did not reach the blossoming stage and were killed to the ground by the first frost. I judge that it will have no value here as a fodder plant.

Spurry (*Spergula arvensis*). — Two varieties, "small" and "giant," were under trial on a small scale. Neither produced fodder enough to make it of value.

Ankee Grass (*Panicum crus-galli*). — Seed of a variety of this species (the same as that to which our Japanese barnyard millet belongs) was received from the United States Department of Agriculture, with the request that we submit it to trial. It was stated that it had been collected by C. R. Orcutt, and that the seed was used as food by the Indians of South California and Arizona. The seed was sown May 4, and the crop was given careful culture. The plants grew about 5 feet tall, the stems were coarse, harsh and woody, brown in color, quite leafy. Panicles open like those of the common weed (barn-yard grass), but without awns, large. Seeds did not ripen. As compared with the Japanese barnyard millet, this variety is not as tall, coarser and more

woody and much later. It is decidedly inferior to the Japanese variety in every respect as a fodder crop for this locality. It is quite probable, however, considering its origin, that the Ankee grass will endure drought better than the Japanese barn-yard millet.

Millets under False Names. — The reputation of some of our Japanese millets is such that seed has for the last two years been offered in some quarters which is not genuine. We have received and tested three such samples, from widely different sources. In one of these cases the mistake may have been inadvertent. The variety was sold as Japanese barn-yard millet; it proved to be the Japanese panicle millet, — a widely different sort. *It should be remembered that we have sent out three Japanese millets, viz., the barn-yard, panicle and common. The first we consider to be the most valuable as a fodder crop.*

Sulphate of Iron as a Fertilizer.

A recent English work on manures and fertilizers* lays great stress upon the value of *sulphate of iron* as a fertilizer, and contains figures giving the results of many apparently careful experiments, all tending to show that this chemical often has a considerable influence in increasing crops. The opinions of Mr. Griffiths upon this point, so far as I am aware, are not shared by most authorities, and I had not much confidence that experiments here would give results similar to those he reports. Still, it is our place to put such questions to the test. Accordingly a piece of land that for some years has been manured yearly at the rate of 600 pounds ground bone and 200 pounds muriate of potash per acre, and which has produced a variety of crops, including grass, potatoes and clover, was selected for the purpose. It was divided into four plats, and all received the customary application of bone and potash, applied in September, 1895. These plats contain one-thirtieth of an acre each. The crop was the medium green soya bean, planted June 13. Sulphate of iron was applied to two of these plats, Nos. 1 and 4, on June 24, just as the beans were coming up, at the rate of 80 pounds per acre.

* Griffiths, "Farm Manures."

It has been claimed by Griffiths that the use of this salt favors chlorophyll formation, and that it therefore causes a perceptibly deeper shade of green in the leaves in the plants to which it is applied. No difference could be detected during the season. The average crop (cut green for the silo) where the sulphate of iron was applied was 462½ pounds, the average of the other plats 445 pounds, — a difference of 17½ pounds in favor of the treatment, or at the rate of 525 pounds per acre. I consider this difference too small to be of much significance.

"Bug Death."

This is a preparation sent to us by the Danforth Chemical Company, Leominster, Mass., as a substitute for Paris green as a poison for potato bugs and as a preventive of blight. It was received late in the season, the "bugs" being full grown when we were able to use it the first time. It kills them, but not as quickly as Paris green; and as, in showery weather particularly, rapidity of action is desirable, I do not look upon it as equal in value to that poison for this and similar purposes. The "Bug Death" had no apparent effect in preventing blight.

Atomizer for applying the Bug Death.

The Danforth Chemical Company sent with the "Bug Death" a large atomizer, which they recommended for its application. This material and similar dry poisons can be applied with this atomizer, but it is entirely unsuited to use upon a large scale. The hand soon becomes excessively and painfully weary from the motion required, while the time occupied is far greater than by other means which are within the reach of all. It required twenty-eight minutes to cover a row with the atomizer, while the same length of row was covered by the use of Leggett's gun in eight minutes.

Fungiroid.

"Fungiroid," sold by the manufacturers of Leggett's dry insect powder gun as a means of preventing potato blight, has been given a thorough trial. Both the "*Fungiroid*" *in combination with Paris green*, furnished and recommended by the company, and in the latter part of the season, when

the bugs had ceased to be troublesome, the *pure "Fungiroid,"* were employed. The season was hot, with frequent showers, furnishing, therefore, conditions highly favorable to the development of parasitic fungi, and extremely unfavorable to the action of the "Fungiroid." It was, however, reapplied at frequent intervals, and always after a heavy rain and while the vines were moist.

The treatment was applied to one row each of the 60 varieties in our variety test. One row each of 38 of these varieties, in an adjoining plat, upon similar soil and grown under precisely similar conditions, was left untreated. No difference whatever could be detected in the extent to which blight affected the treated and untreated vines. "*Fungiroid*" *and Paris green mixture* (prepared) was applied at the rate of 2 pounds per acre to the vines of the treated plat with Leggett's gun, and in accordance with directions, on each of the following dates: July 13, 18, 22 and 24. Pure "Fungiroid" was applied twice, at the rate of 1½ pounds per acre, and in the same manner, on August 1 and 3. By the latter date blight had affected all varieties in the plat and to a considerable extent in most cases. The yield from 38 rows treated as described was 7,887½ pounds of large and 983 pounds of small potatoes. The 38 rows which were untreated produced 8,407 pounds of large and 960 pounds of small tubers. The results surely indicate no favorable influence due to the use of "Fungiroid."

Scab of Potatoes.

It has been thought by some experimenters that, by an application of sulphur at the time of planting, "scab" of potatoes, even in infected soil, could be prevented. Accordingly, as we had such an infected soil where a very scabby crop was raised last season, it was decided to test this point. The plan of the experiment was as follows: one-half the seed required was treated with corrosive sublimate solution in the usual way; then 240 hills were planted with each kind of seed (treated and untreated), and in the furrow with one-half of these hills sulphur at the rate of 300 pounds per acre was scattered at time of planting. The table below shows the results: —

Sulphur for Prevention of Scab of Potatoes (120 Hills Each).

TREATMENT.		Large Tubers.			Small Tubers.
		Free of Scab (Pounds).	Slightly Scabby (Pounds).	Badly Scabby (Pounds).	
Seed treated with corrosive sublimate,	no sulphur,	21	78½	48	24
	sulphur, .	2	80½	56	15
Seed untreated,	no sulphur, . .	2 tubers	70½	84½	19½
	sulphur, . .	3 tubers	67	96	20

The use of sulphur in the drill appears to have been absolutely without effect. The table indicates that even when seed is planted in infected land the treatment with corrosive sublimate is somewhat beneficial.

Trial of Hay Caps.

Another season's use, and very frequent and extended use, of the three styles of hay caps mentioned in my last report, viz., the Symmes' paper board, oiled cotton and cotton impregnated with tannin, has led to the following conclusions : —

1. Caps of some sort are extremely useful, especially with such crops as clover, millets, oats and peas, and other slow-curing crops, especially those much injured by excessive handling.

2. The Symmes' cap is most quickly applied, — an important point, — and is best liked. It appears to be wearing very well.

3. Of the two styles of cloth caps in use, those impregnated with tannin are most durable. The oiled caps are more mildewed than the others and have become much more torn.

4. It has been found that in some cases, where clover has been cocked quite green and covered with the three kinds of caps and allowed to stand for some time with frequent rains, it has kept better under the cloth than under the Symmes' caps. The porosity of the former in such cases appears to be an advantage.

Poultry Experiments.

Poultry experiments were continued during the winter of 1895–96 upon a small scale. Our attention has been confined to two points, viz.: —

1. Effect upon egg-production of the use of condition powders.

2. Comparative value for egg-production of dry ground animal meal and cut fresh bone.

1. Effect of Condition Powder upon Egg-production.

The experiment to test the value of condition powder in feeding for eggs was begun February 9 and continued until April 28. We used two lots of fowls, selected with the utmost care with respect to similar characteristics in the two lots. Each lot contained 3 barred Plymouth Rock hens, 8 light Brahma hens, 6 light Brahma pullets and 2 Wyandotte-light Brahma pullets. The hens were one and three-quarters years old at the time the experiment began. Each lot, consisting of 19 fowls, occupied a detached house having two compartments (scratching shed and closed roosting and nest room), respectively 8 by 12 and 10 by 12 feet in size, the nest room with two windows. These houses adjoin each other and both have precisely the same exposure. The two lots were fed as follows: in the morning they received a mash which was mixed hot the previous evening; at noon, and again one hour before sundown, whole grain was scattered in the straw in the scratching sheds. Artificial grit, oyster shells and pure water were kept always before them. The only difference in the management of the two lots was that condition powder was mixed in the mash for one lot, in accordance with directions furnished with the powder. This experiment seemed important, in view of the large amount of money, in the aggregate, which is expended in the purchase of such powders; and, notwithstanding the very general impression that they are useful, in the absence of any definite proof of the fact. *I would call especial attention to the fact, — which, though generally well known, is often lost sight of, — that no one experiment can settle this question in the one way or the other.* The results of this experiment are pub-

lished, then, not as settling the question, but simply as evidence bearing upon an important point, to be accepted only for what it may be worth.

The foods used in this experiment and in the other described later, and their composition, are shown below: —

Composition of Air-dry Foods used in Poultry Experiments (Parts in 100).

	Water.	Crude Ash.	Crude Cellulose.	Crude Fat.	Crude Protein.	Nitrogen-free Extract.
Ground clover,	9.53	7.43	27.80	1.93	13.65	39.66
Wheat bran,	9.56	5.27	8.85	5.37	17.69	53.26
Animal meal,	5.08	28.63	–	16.18	40.03	10.08
Cut bone,	29.67	24.06	–	26.13	20.19	–
New-process linseed meal,	9.35	4.48	6.58	6.39	38.06	35.14
Buffalo gluten meal,	7.14	.84	7.07	12.67	23.31	48.97
Chicago gluten meal,	8.10	.83	3.34	5.57	36.51	45.65
Wheat middlings,	10.93	4.03	6.95	5.30	17.28	55.51
Whole wheat,	10.60	1.69	2.17	1.93	13.19	70.42
Whole oats,	10.06	2.77	8.71	4.87	14.53	59.06
Soya-bean meal,	9.24	5.02	3.87	16.25	34.75	30.87

The kinds and total amounts of the several foods used in this experiment for the lot of fowls having condition powders are as follows (in pounds): whole wheat, 100; whole oats, 99.5; wheat bran, 19.8; wheat middlings, 19.8; ground clover, 19.8; new-process linseed meal, 9.9; animal meal, 9.9; soya-bean meal, 9.9; cut bones, 3. Two pounds of condition powder were used. All the meals, bran, middlings, ground clover and bones were given in the form of the morning mash. The total number of pounds of food used was 291.6. The nutritive ratio, based upon composition (as digestibility by fowls is not known), is 1 : 4.5. The cost of all the food used was $3.43, not including the condition powder.

The lot of fowls which received no condition powder received foods as follows (in pounds): whole wheat, 99.5; whole oats, 100; wheat bran, 19.3; wheat middlings, 19.3; ground clover, 19.3; new-process linseed meal, 9.7; animal

meal, 9.7; soya-bean meal, 9.7; and cut bone, 3. Total number of pounds, 289.5; total cost, \$3.39; nutritive ratio, 1 : 4.5.

The results and leading details of the experiment are shown in the table below: —

Condition Powders for Egg-production.

Experiment, February 9 to April 28.	Duration of Experiment.	Total Food consumed.	Cost of Food per Day per Fowl.	Number Eggs produced.	Dry Matter in Food per Egg.	Cost of Food per Egg.
	Days.	Pounds.	Cents.		Pounds.	Cents.
19 fowls, condition powder, ...	79	291.6	.23	163	1.611	2.1
19 fowls, no condition powder, . .		289.5	.23	195	1.333	1.8

In the above estimate the cost of the condition powder is not included. This amounts to \$1, which would make the cost per egg 2.7 cents in the case of the fowls receiving it.

The fowls receiving no condition powder laid their first egg on February 12; those receiving it, their first egg on March 16, at which time the other lot had laid 24 eggs. One hen in each lot died during the experiment. At its close the fowls in both lots appeared to be in about equal condition of health, but two in the condition-powder lot had begun to moult, while there were no indications of moulting in the other lot. There was no material difference in the size or appearance of the eggs from the two lots. This experiment is now being repeated, with lots of pullets most carefully selected with reference to it, having been begun on Jan. 1, 1897.

2. *Animal Meal v. Cut Bone for Egg-production.*

The general conditions of this experiment were similar to those in the experiment to test the value of condition powder. Each house contained 2 barred Plymouth Rock and 10 light Brahma hens, 5 light Brahma pullets and 2 white Wyandotte-light Brahma pullets; total, 19 fowls. The experiment began February 9 and ended April 28.

The food received by the lot having cut bone was as follows (in pounds); whole wheat, 99.5; oats, 100; wheat

bran, 18.5; wheat middlings, 18.5; Chicago gluten meal, 18.5; ground clover, 18.5; cut bone, 10; total, 283.5 pounds; cost, $3.25; nutritive ratio, 1 : 4.8.

The other lot received essentially the same foods, except that in place of the bone it got 9.7 pounds of animal meal; total food, 287 pounds; cost, $3.26; nutritive ratio, 1 : 4.9.

The leading details and results are shown in the following table: —

Cut Bone v. Animal Meal for Egg-production.

Began February 9, ended April 28.	Duration of Experiment.	Total Food consumed.	Cost of Food per Fowl daily.	Number of Eggs produced.	Dry Matter in Food per Egg.	Cost of Food per Egg.
	Days.	Pounds.	Cents.		Pounds.	Cents.
Cut bone lot,	79	283.5	.22	269	.940	1.2
Animal meal lot,		287.0	.22	145*	1.796	2.2

* One soft shelled.

In the above estimate of cost the labor required to cut the bones is included. The results indicate a decided advantage in favor of the bone. During last year two experiments were tried, one of which resulted favorably to the bone, the other to the animal meal. Last year there was some diarrhœa among the fowls having bone, this being given alone. This year the bone was fed in the mash, and there has been no such trouble. There has been this year no perceptible difference either in the condition of the fowls in the two lots or in the size or character of the eggs produced. The experiment indicates, then, a decided advantage in favor of the cut bone. This experiment is now being repeated.

REPORT OF THE METEOROLOGIST.

LEONARD METCALF.

During the past year the usual meteorological observations have been continued, and the results have been compiled with those of previous years. A special bulletin will be published with the annual summary of observations for the year 1896, in January, 1897, giving the mean annual and the maximum and minimum records for this station for the past eight years, *i.e.*, since the equipment of our observatory.

The advisability of making a change in the time and frequency of taking the observations, from tri-daily readings at 7 A.M., 2 P.M. and 9 P.M., to bi-daily readings at 8 A.M. and 8 P.M., to conform with the present method of the U. S. Weather Bureau, was considered; but, after discussing the subject thoroughly with the department at Boston and at Washington, it was deemed unwise to make the change, and the observations have therefore been taken three times a day, as heretofore.

After a careful study of the thermometer records of the tower shelter, it was found that the local conditions of exposure were such as to seriously affect the accuracy of the temperature readings, and the Draper thermograph, by which the mean daily air temperature at the tower was found, was removed to the ground shelter, where its readings are checked and corrected three times a day by a standard mercury thermometer and by the maximum and minimum thermometers previously kept there. While record is still kept of the maximum and minimum air temperatures in the tower shelter, it is no longer published. The wet and dry bulb thermometers were also removed to the ground shelter, and the wet-bulb reading or "sensible temperature" of the air is now published, as well as the dry-bulb reading. This "sensible

temperature" is of course the temperature of the atmosphere as we ordinarily feel it, as the sensible temperature is directly dependent upon the relative humidity of the air, and hence upon the cooling effect of the evaporation of the surface moisture.

After a careful comparison of the rainfall records of the ground and the tower, obtained in each case by United States Weather Bureau rain gauge, it was found that the tower records were so affected by upward wind currents, due to the shape of the roof, as to render them of very doubtful value. The tower "precipitation" observations have therefore been discontinued.

Some additional records have been kept during the past year and will be continued this year. Among these are the number of days of sleighing and the amount of snow on the ground at the beginning of each week, the latter being reported to the New England Weather Bureau weekly. Record has also been kept of the accuracy of the forecasts received daily at this station; this record shows that, while the monthly percentage of correct forecasts has varied from 69 per cent. to 90 per cent. during the year, the mean percentage of accuracy of forecasts has been 78 per cent.

A few new instruments have been added to the station's equipment: two sets of Green maximum and minimum thermometers; six mercury thermometers, United States Signal Service pattern, made by Green; and a thermophone,* with four resistance temperature coils, made by E. S. Ritchie & Sons, the latter instruments being intended for experiments on soil temperatures.

Through the courtesy of Professor Whitney, one of his assistants, Mr. Thomas H. Means of the Division of Soils, Department of Agriculture, was sent to Amherst in the middle of July to install a set of Professor Whitney's apparatus for the determination of soil temperature and moisture. Soil-temperature electrodes and moisture-resistance plates were buried in grass land, a short distance from the ground shelter, at five different depths, from the surface of the ground to a depth of two feet; and from that time, the middle of

* The thermophone was recently designed and patented by Messrs. Henry E. Warren and George C. Whipple.

July, until the latter part of August, when the reading instrument broke down, daily records of the soil temperature and moisture were taken. The reading instrument above referred to was designed by Professor Whitney, and is a form of Wheatstone's bridge, reading the electrical resistance of the temperature cell and of the soil itself, from which data the temperature and moisture of the soil are computed.

Early in September the thermophone was received from Messrs. Ritchie & Sons, and its temperature-resistance coils were buried not far from the Whitney apparatus, at depths of three, twelve, twenty-four and thirty-six inches respectively. On this have been taken tri-daily soil temperature observations to the present time, and these records will be continued throughout the winter, the results being plotted each month, at its close, for purposes of comparison.

In the spring the thermometer coils will probably be taken up and put down in another place for observations, together with other instruments, on soil and air temperatures on an experimental corn plot; as plans have been formulated in co-operation with Doctors Allen, True and Whitney of the Department of Agriculture at Washington, and considerable work has been done preliminary to undertaking at Amherst a series of experiments bearing upon soil temperatures and moistures in their relation to the growth and advancement of crops.

REPORT OF THE HORTICULTURIST.

SAMUEL T. MAYNARD.

The number of varieties of fruits tested during the past season has been greatly increased, and the testing of a large number of varieties of vegetable seeds has been added to the work.

A large addition of varieties of apples, Japanese plums, peaches, cherries and the new species of raspberries and blackberries has been made by purchase of young stock, or by budding or grafting into stocks already established.

Spraying.

The protection of fruit and garden crops from insects and fungous pests has formed an important part of the work of this division, the results of which again emphasize the fact that good fruit cannot be grown without more or less use of insecticides and fungicides. The most approved apparatus and the new methods of application, as well as the new insecticides and fungicides, are given a very careful trial as soon after their introduction as possible.

The insecticides most used are Paris green, kerosene emulsion, hellebore and pyrethum or insect powder. In the greenhouses lemon oil has proved the most valuable substance for keeping down scale and mealy bugs.

The fungicides most used are copper sulphate solutions, Bordeaux mixture and ammoniacal carbonate of copper.

Dry Bordeaux Mixture.

During the winter and spring many inquiries as to the value of the dry Bordeaux mixture and methods of manufacture were received, and several parties began its manufacture and put it on the market. Many samples were sent us for

trial, and the results of the tests were carefully noted. As far as can be determined from one season's trial, the results have *not* been satisfactory, for the following reasons: first, that the material is not in sufficiently fine condition; second, that it is impossible to make it adhere for any considerable time to the foliage or other parts of the plants even when applied to a wet surface; third, that there is a great waste of material, much of it falling to the ground. After careful investigation, we have not noticed any marked beneficial result following its use. For the above reasons, the dry Bordeaux mixture does not appear to be as efficient as that in a liquid form.

Steam Spraying Outfit.

One of the greatest obstacles to the use of insect and fungi destroyers has been the difficulty of obtaining pumps of sufficient power to enable the application of liquids to be made thoroughly, as fast as an ordinary team would move along among trees or garden crops; and a careful trial of a steam spraying outfit has been one of the features of the past season's work. As the result of repeated trial, we feel warranted in the assertion that, when run with care and skill, very satisfactory work can be done better and more cheaply than when done by hand or by the gear machines. It is of course understood that the manipulator must be thoroughly acquainted with the construction of the engine and pump, and be skilful in keeping all parts in perfect working order. The cost of such spraying outfits, of which several are now offered in the market, and ranging in price from $200 to $400, is much against its use by the small farmer or fruit grower; but in almost every village or town the work of spraying for a large number of individuals by the single owner of an outfit could be done at a less cost than if each person were to equip himself with small and imperfectly working pumps. This would probably be found more satisfactory than if the outfit were owned by a number of individuals. A steam engine suitable for this work, and fitted with a fly wheel, so that the power could be utilized, when not needed for spraying, for cutting wood, corn fodder or ensilage, grinding grain, pumping water for stock or irrigation, would be a source of profit in many directions.

Seed Testing.

Complaints having been frequently received affecting the germinating qualities of seeds and vegetables and their purity, coupled with requests for examination and testing of the same, an extended investigation was undertaken of seeds of standard varieties from prominent dealers in different sections of the country. In all, 367 different packages of seeds were tested, each variety involving four distinct tests. These were obtained from seven of the leading seed dealers, as follows: 4 from Massachusetts, 1 from New York City, 1 from Philadelphia, Pa., and 1 from Detroit, Mich. The number of varieties tested was: beets, 4 (28 packages);* cabbage, 5 (35 packages); cauliflower, 3 (21 packages); celery, 5 (30 packages); cucumbers, 4 (28 packages); lettuce, 7 (27 packages); melons, 5 (23 packages); onions, 5 (30 packages); parsnips, 9 (18 packages); peas, 4 (28 packages); radishes, 6 (24 packages); spinach, 8 (19 packages); squashes, 4 (28 packages); tomatoes, 4 (28 packages).

These seeds were first tested for their germinating qualities by two different methods under glass. These were also noted when planted in the field, and careful observations made and recorded from time to time as to vigor of growth. At the end of the season the characteristics of foliage and products were carefully determined, and the crop of each strain weighed. Each kind of vegetable was planted in soil best suited to its growth, and the seeds from each dealer given the same treatment in every way.

Results.

We are glad to report that with one or two exceptions the vitality (germinating qualities) of the seeds was very satisfactory, about the same per cent. of seeds of each kind from the different dealers germinating, and the products were generally uniform in outline and markings. The varieties sold by the different dealers under the same name generally proved to possess the same characteristics.

* The same varieties, from 7 different dealers.

With the experience gained in this work the past season it is hoped another year that, in addition to similar tests, seeds may be collected from the stock kept on sale in country stores, much of which is produced by growers of little skill, and possibly in localities where mixing by cross-fertilization cannot be avoided. This will entail a large amount of work, a considerable addition to the area of land occupied and much greater expense.

The complete results of the season's test will be presented in tabulated form in a later bulletin.

REPORT OF THE BOTANISTS.

GEORGE E. STONE, RALPH E. SMITH.

The work of this department has followed the plan outlined in the last annual report. Much of our attention during the past year has been devoted to the study of the gall-forming nematode worms affecting cucumbers and tomatoes grown under glass, in the hope of finding some effectual method of combating them. Professor Smith has devoted considerable attention to the study of their life history. The results of the investigations, when completed, will be published in a bulletin.

Most of the correspondence of the department has had reference to plant diseases, although during the summer many inquiries have been received regarding weeds. For the purpose of facilitating their study, we have collected during the past summer about two hundred and fifty species for the herbarium, including several species which have been recently introduced in grass and other kinds of seed. The department takes this opportunity of soliciting correspondence on this subject, as it is desirous of obtaining information in regard to the introduction and distribution of weeds and other plants which may possibly become troublesome.

The Nature of Plant Diseases.

Before passing on to a consideration of some of the plant diseases which have occupied our attention during the past year, it will be well to pay some attention to the nature of plant diseases in general. The diseases with which botanists have to deal can be divided into two classes, namely: first, those which are caused by parasitic fungi, bacteria and similar organisms; and second, those brought about by purely physiological disorders, which have their origin in some ab-

normal condition of the plant, due to improper care and surroundings. While the distinction between the two classes of disorders can in many cases be readily discerned, in other cases it is indeed difficult to discriminate between them, as physiological disorders of the plant so frequently produce just the conditions which are most favorable for the development of parasitic fungi and bacteria. Thus the original cause of the trouble is liable to be entirely lost sight of. Bearing in mind this fact, it must be clear that to recommend fungicides for the treatment of physiological diseases is about as absurd as it would be for a physician to treat a person for consumption who was suffering from malaria or indigestion, and simply required a change in his food or the conditions which surrounded him. The only logical method of treatment under such circumstances is to restore the normal and proper conditions. On the other hand, parasitic fungi which cause serious disorders in our cultivated plants are also found on plants which would pass for quite normal and healthy ones. In fact, probably no plant is entirely exempt from parasites; and here we are brought face to face with the question, What constitutes a plant disease? It may be defined as a disorder caused by any failing in or diversion of the normal physiological actions of the plant. Practically, we include as plant diseases the effects of all of those forms of parasitic fungi which occur on plants, although it is doubtful whether many of them really cause any perceptible harm to their hosts.

Of the two classes of diseases, the parasitic and physiological, those of the latter are more likely to be prevalent in greenhouse plants, inasmuch as the conditions to which the latter are subjected are very artificial, and cannot coincide very closely with those of their normal habitat. The physiological disorders, moreover, are much less likely to be discerned, and, when found, are more difficult to contend with than parasitic attacks, for they are more complicated in their nature, as well as less thoroughly understood. In all our dealings with the plant we must bear in mind that it is a plastic organism, capable of responding, within certain limits, to a great variety of external factors which act as stimuli. These external stimuli are principally to be found

in heat, light, moisture and in the soil conditions. It is therefore the proper application of these factors which the practical grower has to take into consideration, and his success in plant growing will depend largely upon his skill in dealing with them. The minute details connected with the application of light, heat and moisture, the judicious use of fertilizers and the bringing of the soil into proper mechanical condition, are matters which are now commencing to receive some of the attention which they deserve.

Diseases entirely or partially due to Parasitic Organisms.

A Bacterial Disease of the Strawberry (*Micrococcus* sp.?).

During a hot sultry period which occurred in the month of May, 1895, some diseased strawberry plants of the varieties known as the Sharpless and the Belmont were sent to the botanical department from Fitchburg, Mass., for the purpose of determining the nature of the disease and the remedies for the same. The freshly gathered plants showed by their dark-colored, shrivelled leaves that they had been killed outright in the field by some unknown cause.

A careful microscopic examination of the plant proved that there was nothing of an insect or fungous nature to which the trouble could be attributed; but by making more careful observations of the cell contents of the roots and leaf petioles, numerous bacteria (micrococci) were found, which at least indicated a possible cause of the disease.

At about the same time these specimens were received, the disease made its appearance on many of the strawberry plants in the college plats, resulting fatally to the plants in numerous instances, besides leaving others in a dilapidated condition. The variety which suffered the most in the college plats was the Marshall.

In order to ascertain whether the two diseases were identical, and whether the bacteria were the specific cause of the disorder, the organisms were isolated, and a number of pure cultures made in the ordinary sterilized nutrient gelatine. In this medium the bacteria developed quite readily, producing a white, flocculent mass at the bottom of the tube. Its

manner of growth in gelatine proved it to be of an anærobic * nature. From time to time the organism was transferred to fresh gelatine ; and during the next fall three varieties of strawberry plants, including the Marshall, Belmont and Sharpless, were transplanted to the greenhouse. After the new plants, which were not especially robust, had made some growth, they were placed in a warm, humid atmosphere, and the roots of a number of plants of each variety were inoculated with the pure cultures of bacteria from the gelatine tubes. As a result of the inoculation, the plants after a few days showed the effects of the disease, some, however, more than others ; but in all cases the disease was somewhat milder than in the plants originally affected. An examination of the affected parts of the plant showed the same bacterium, and cultures made from the petioles and roots gave the same characteristic micrococci. Other strawberry plants were again inoculated with the new isolated forms, with corresponding results.

No further experiments in this direction were considered necessary, inasmuch as the effects of the bacteria upon the plants had been ascertained. I will state here, however, that I had never seen the disease previous to this, neither have I been able to detect it since. I consider it one of those sporadic afflictions with which any plant is likely to be troubled, provided just the right conditions are at hand. In this instance the conditions of the weather and that of the plant were especially favorable for such an attack. All of the plants under examination were young, and had not been transplanted a great while ; and, furthermore, they had all the appearances of plants which had not become firmly established in the soil. The organism is, not unlikely, a common form of micrococcus which under peculiar conditions is liable to cause some injury. Inasmuch as the primary cause of the disease has its origin in a weakened condition of the plant, and inasmuch as there is every reason to believe that the organism gains its entrance through the root, any attempt to apply fungicides would be useless. The only practical method of dealing with a difficulty of this kind, should it occasionally make its appearance, is to take more pains in

* Not requiring free oxygen.

securing a rugged stock and to keep a more watchful care over the plants during their critical period of transplanting, thus rendering them less susceptible.

A Stem Rot of the Cultivated Aster.

My attention was first called to this disease during the fall of 1895, while visiting the florist, Mr. L. W. Goodell of Pansy Park, who raises a large variety of asters for seed. The specimens obtained from Mr. Goodell were gathered rather late in the fall, when the disease was far advanced, being characterized at this stage of its development by a general blackened and shrivelled condition of the whole plant. Closer observation of the specimen, however, located the point of attack on the stem, close to the root, where the epidermal tissues which surrounded the abnormally hardened wood were more or less disintegrated.

A microscopic examination of the tissues of the affected parts showed a variety of organisms, such as bacteria (micrococci), nematode worms, and such mould-like fungi as Alternaria, Macrosporium and Physarium. Some of these organisms alone might give rise to the disease, but it is more probable that most of them were merely accompanying factors of the diseased conditions to which the plants were subjected.

The bacteria and nematode worms were by far the most abundant, the bacteria especially being widely distributed through the tissues, on that part of the stem adjacent to the roots. Owing to the fact that all of the material at our disposal was in too advanced a stage, it was impossible to arrive at any definite conclusion in regard to the cause of the disease. Since examining the specimen obtained from Mr. Goodell we have heard of the disease as occurring in other places. Among them may be mentioned Mr. Joseph Ammer of Springfield, who writes us as follows: —

Dear Sir: — In reply to your favor of September 21, I am sorry to say that I cannot send you a specimen of the aster plants, because they are all past. The plants appeared to be in a good and vigorous condition up to the time of setting flower beds, when they began to wilt very rapidly, and in a little more than a week a whole bed of seventy-five or one hundred plants was nearly if not

quite gone, save perhaps eight or ten. On closer examination I found that the stock right at the surface of the soil for about an inch appeared soft and pulpy and could be scraped away to the hard heart, which in most cases was black and dead. I could not account for it in any way, unless it was some fungous disease.

There are many others around here who are troubled the same way; some called it lice on the roots, others "aster blight," and let it go at that. The varieties most affected were "Queen of the Market," "Victoria" and the "Comet," while the new "Giant White Comet" was entirely free from it, although separated from the worst bed only by a four-foot path.

If you can suggest any treatment, I should be glad to try it another year, for I dislike to be obliged to give up growing asters, but will have to unless some remedy can be found for the trouble.*

The disease is one that requires further investigation, especially in the field near greenhouses where the asters are grown, in order that the first stages can be more closely observed. The cause of the disease is not unlikely due to some improper method of cultivation; at all events, it is not desirable to recommend any method of treatment until more is known about it. In one instance, when the plants were badly affected in 1895, they were raised in a new field the following season, with the same disastrous results.

In this connection we wish to state that Professor Smith observed some aster plants in a small bed last summer quite similarly affected, but in this instance the death of the plants was undoubtedly caused by a small grub which devoured the roots.

"Leaf Spot" of Decorative Plants.

We use here the term "decorative" in a special and limited sense, as it is ordinarily used by florists, meaning to include such plants as palms, Dracænas, Ficuses, etc., which are used mostly or entirely for the ornamental effect of the plant as a whole, and this on account of the leaves. Specimens of such plants may be found in almost any florist's establishment, the leaves of which are more or less "spotted;" that is, certain portions of the leaf are dead and withered,

* We attempted to obtain specimens of diseased plants from the Springfield growers, but unfortunately it was so late in the season when the disease was reported from this locality that we were unable to do so, as the affected plants had been destroyed.

and contrast prominently with the surrounding green tissues. Sometimes all the leaves on the plant are affected; again, only a few show any spotting. Sometimes almost the entire leaf is dead; in other cases, only a small spot. Such plants, if at all seriously affected, are of course almost valueless for decorative purposes, and even in less serious cases their beauty is greatly impaired; consequently it is well worth an effort to get rid of such disfigurations, and prevent their reappearance. In order to do this, we must first know the cause or causes of the difficulty. They are extremely various. Any injury, or weakening of the vitality of the plant in any way may produce the effect indicated by the well-known expression "leaf spot." It may be nothing more than a simple burn, produced by the sun's rays concentrated in passing through the glass roof and drops of water on the leaves, or, as frequently happens, by contact of the leaves with the heating pipes. The attacks of insects also sometimes have quite a similar effect. But the trouble is not always so obvious. Various other agencies conspire to produce the effect which we are considering.

It may be stated, as a general principle, that the healthy and rapidly growing plant is the least likely to fall a prey to disease. Exceptions to this may be found in the case of unusually vigorous outbreaks of the most destructive diseases, but in the long run the rule holds good. Let the plant become weak and sickly from improper and insufficient nourishment, too much or too little heat, light, water, etc., poor ventilation or drainage, or any other disturbance of its normal functions, and its liability to disease becomes largely increased. At such a time the weakening of the plant's vitality may proceed so far as to cause a gradual dying away of the leaves and thus produce spotting, or it may, and always does, favor the attacks of parasitic vegetable organisms, most of which belong to the class called the fungi. Such attacks, together with those of bacteria and other vegetable organisms of low rank, are alone properly considered as plant diseases. The fungi are true plants, but of low order and microscopic in size. Some of them are strictly parasites, *i.e.*, they can live only upon the tissues of other organisms. Others, like the toad-stools, are strictly saprophytes, *i.e.*, they live only

upon dead and decaying organic matter. These are entirely harmless to plant life. Still others, while ordinarily saprophytes, have parasitic tendencies, and may attack plants in a weak and unhealthy condition. A sickly or injured plant may be attacked by a variety of such forms, together with true parasites, bacteria, insects and other organisms both of the animal and vegetable kingdoms, making it impossible to say which was the original cause of the trouble, if, indeed, any one of them could be strictly considered as such.

A leaf spot produced by fungi is a place on the leaf where a fungous plant has become established and consumed the vital substance. The spot becomes larger as the fungus grows out into new tissue. Fungi reproduce themselves by *spores*, corresponding to the seeds of higher plants. These spores are of course extremely minute, and are produced in infinite numbers. They are smaller than the finest dust, and float about in the air with the greatest readiness.

In the treatment of fungous diseases only one course of action can be successful. This is *prevention*. A leaf once infested with a fungus can never be restored to its normal condition, for not only is the fungus within its tissues and out of reach of any treatment, but, furthermore, certain parts of the leaf are already dead, and can never be restored. One method of preventing such diseases is by killing the spores before they can germinate. The now common operation of *spraying* consists in applying to plants affected or liable to be affected by disease certain substances diluted with water to a strength sufficient to destroy the fungous spores but not injure the leaves. This solution is applied in the form of a fine spray, by means of a pump and nozzle. The application of this method is now well established in the treatment of most of our destructive plant diseases, especially those affecting fruits and vegetables. The most effective substance thus far discovered for spraying purposes is the so-called Bordeaux mixture, — a sort of blue whitewash, made by combining lime with copper sulphate (blue stone, blue vitriol). Many other substances have been tried, some with great success; but the Bordeaux mixture is still the most satisfactory for general purposes, for it kills the spores, sticks to the leaves and does not injure the plant.

But in the case of decorative plants, even if the Bordeaux mixture effectually prevented disease, its use would involve a serious disadvantage. Imagine a fine palm or Ficus covered with blue whitewash! It would certainly be more disfigured than by any disease. We have, however, other fungicides which have given very satisfactory results in the treatment of plant diseases, and which, being clear solutions, leave no stain on the plant. Among these the so-called ammoniacal copper carbonate solution is one of the best. It is prepared by dissolving one ounce copper carbonate in strong ammonia (26°), of which about one pint will be required. The copper carbonate should be put into a wooden pail with sufficient water to make a thick paste, and the ammonia then added. The resulting solution is then diluted with about nine gallons of water.

But, aside from any method of spraying, much can be done for the eradication of spot diseases by removing and destroying all affected leaves, etc. This must be done promptly and thoroughly, in order to be effectual. As soon as a leaf is seen to be spotted, it should be removed and *burned.* This will certainly lessen the extent of the disease, and will in many cases entirely eradicate it, if the plant be kept in good growing condition. We would recommend, however, that all plants which have been or are liable to be attacked by such diseases should be sprayed with the above-described solution, the frequency of the operation varying with circumstances. A plant which has been diseased should be sprayed three or four times, at intervals of about two weeks. If then no further indications of the disease appear, spraying may be discontinued altogether, or the whole house may be thoroughly wet down with the solution every month or two, as a general precaution. (If the house contains any particularly delicate or valuable plants, it may be well to try the solution on a small scale on them before applying it generally. We have experimented with quite a variety of common greenhouse plants, and have experienced no harmful results. The solution should be diluted to the full extent recommended.) Spraying apparatus can be obtained of any dealer in agricultural implements.

But, after all, the perfection of spraying methods, however

successful, is not the *ne plus ultra* of the science of growing plants. We would not in the least disparage the most exceedingly valuable results of the work done by experiment station workers and others in this direction. There can be not the slightest doubt that millions of dollars' worth of fruit and vegetables have been and will continue to be saved from destruction by this means. But the fact remains that success in growing plants, as in every other direction of human industry, comes not from the observance of any laid down rules and formulas, but rather is the reward of long experience, close application and intelligent skill. The triumph of the gardener's art is the plant brought to perfection in a natural, normal and healthy manner, and not that which owes its existence to skill in doctoring.

We will now briefly describe a few leaf-spot diseases which have come to our notice and which have received little or no public mention. The treatment which we have recommended will apply of course to these and any other similar diseases.

A Leaf Spot on Ficus elastica (India Rubber Plant).

(*Leptostromella elastica*, Ell. and Ev.).

The rubber plant, which is used quite extensively for ornamental purposes, on account of its large, dark-green leaves, is not often attacked by disease. In our own houses and also in other places in this State we have, however, recently found plants affected by a serious spotting of the leaves. The first indication of the disease is seen in the leaf's turning in small spots or streaks, which rapidly increase in extent, changing from yellow to a brownish color and finally to an ashy gray, when the affected portion is quite dead. At this stage the spots may include a large portion of the leaf or only a small part of it. There is often more than one on a leaf, but never a large number. The dead portion is sharply distinct from the living, and banded by a narrow black margin. Upon its surface little black dots appear, which are cavities containing the spores. The spots keep increasing in extent, until the leaf finally loses its vitality and falls from the plant. No plant more than ficus shows the effect of such a disease as this, since its handsome, dark-green leaves are its only ornamental feature.

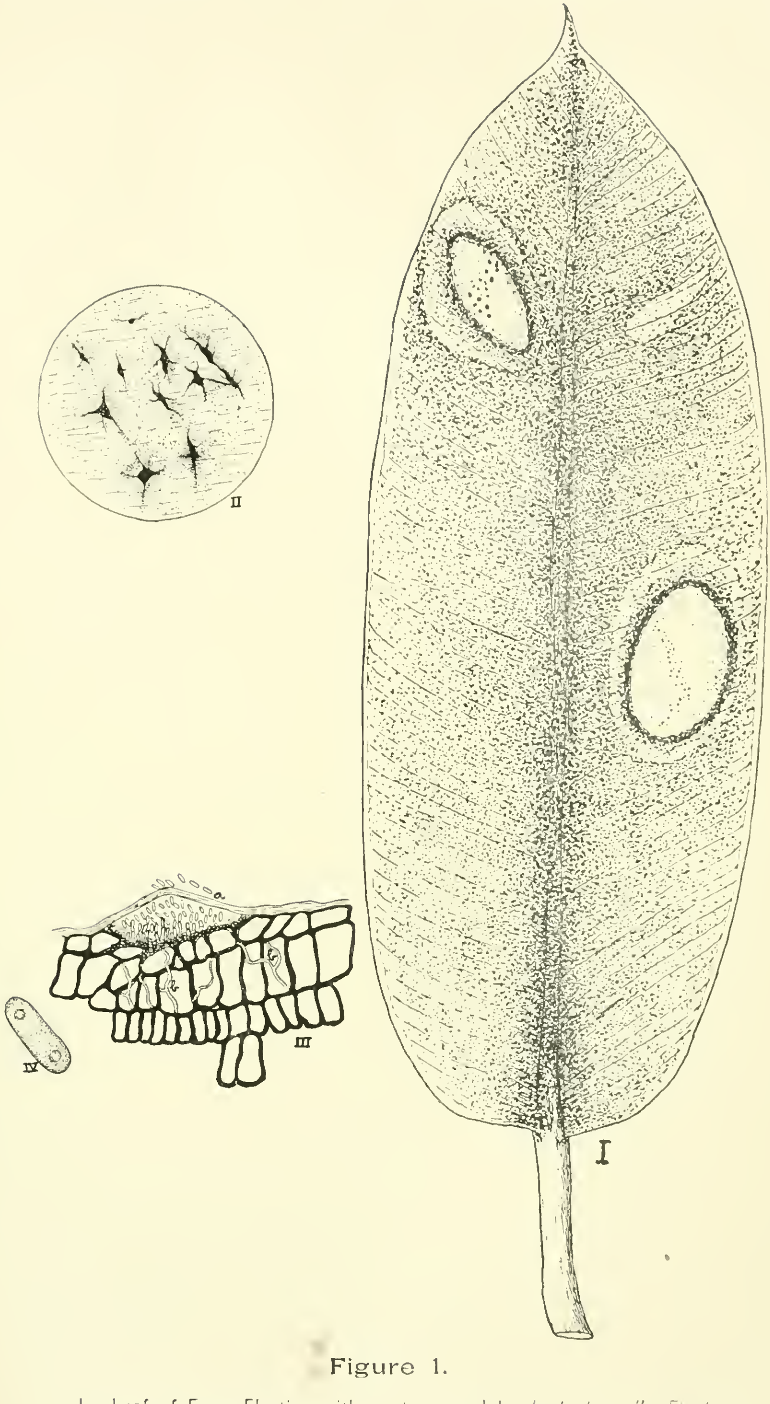

Figure 1.

I. Leaf of Ficus Elastica with spots caused by *Leptostromella Elastica*.

II. Surface of dead area enlarged, showing spore bearing cavities

III. Cross section of dead area with spore cavity at *a* and filaments *b*, running among the cells of the leaf

IV. A spore x 1300.

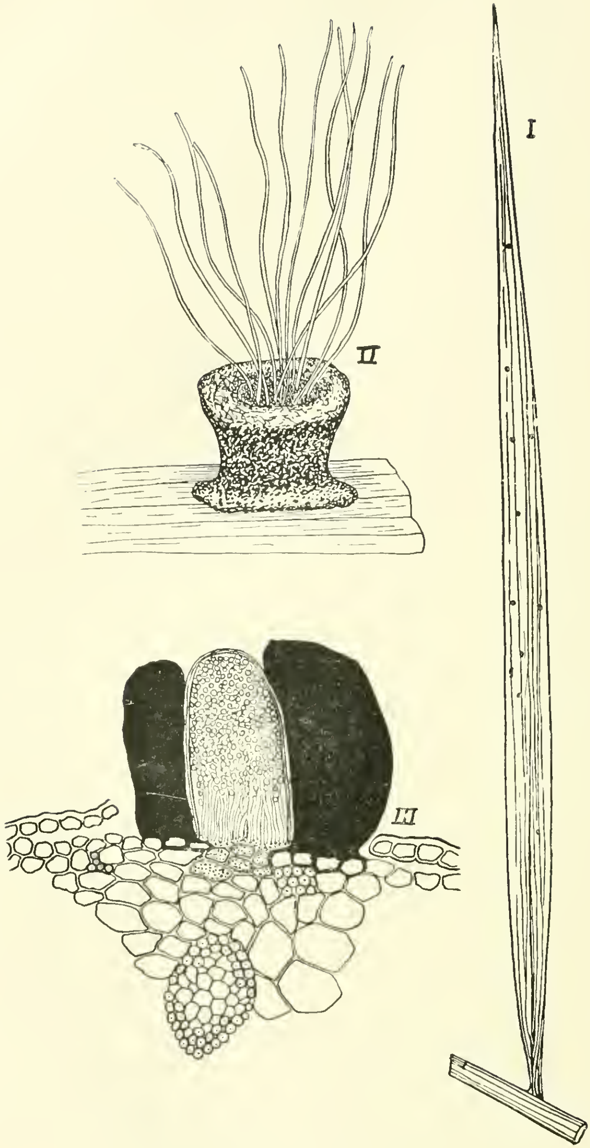

Figure 2.

I. Leaf of Phornix Canariensis attacked by *Graphiola Phornicis.*

II. Spore bearing conceptacle enlarged.

III. Section of a conceptacle full of spore, and portion of the leaf.

This disease was first brought to notice by Prof. F. L. Scribner, in "Orchard and Garden," January, 1891, and scientifically described at about the same time by Mr. J. B. Ellis, from specimens sent by Professor Scribner. We find no mention of it since that time, which seems to indicate that it is not generally prevalent. Should it become so, it cannot fail to become very troublesome, for it spreads with considerable rapidity, and has a ruinous effect upon the decorative value of the plant. It was introduced into our houses, apparently, on a variegated-leaved Ficus elastica purchased from an outside florist. From this plant it spread to others of the ordinary green-leaved type, and has practi cally ruined several fine specimens. Great care should therefore be taken, in purchasing stock outside, that it be free from disease. (Not infrequently we hear of Ficus plants whose leaves turn yellow and drop off. This marks the normal end of the existence of the leaf, or, if it occurs extensively, an unhealthy condition of the plant, and is not to be confused with the fungous disease. An effect almost exactly similar, superficially, to that of the latter, is sometimes produced by sunburn.)

A Leaf-spot Disease of the Date and Similar Palms (*Phœnix* sp.).

(*Graphiola Phœnicis*, Poit.)

This disease is by no means a new or unknown one, but it has received little attention from an economic stand-point. It attacks various species of Phœnix in cultivation, and injures and disfigures them to a considerable extent. The affected parts of the leaf become mottled with yellow, and upon the surface little black eruptions appear, which are cup-shaped conceptacles produced by the filaments in the interior of the leaf, and in which the spores of the fungus are produced. These little eruptions are about one-fiftieth of an inch high and twice as wide, — plainly visible, therefore, to the eye. They consist of a firm, dark-colored exterior layer, enclosing a more delicate inner covering, which contains a mass of thread-like filaments on which the spores are produced. The leaf becomes thickly dotted over on both sides with the conceptacles and slowly shrivels away and

dies, innumerable spores being produced meantime, which are ready to attack new leaves and plants. A fair-sized plant of Phœnix canariensis, sent in for examination and treatment, was found to be badly affected with this disease, and was treated as recommended above. All leaves which showed any sign of the disease (which included all the larger leaves of the plant) were cut off at the base. The plant was then sprayed, and has since developed new leaves which show no sign of the disease, though it is now nearly a year since the plant was received.

A Leaf-spot of the Begonia.

While it may be questioned whether the value of the begonia is strictly that of a decorative plant, in the sense in which we have been using this term, still, it cannot be denied that the plant is often used for this purpose, and on that ground we will consider in this category a spotting of its leaves which has come to our notice. Ordinarily the begonia is seldom affected by disease, insects or any other injurious agency. Still, it is not invulnerable, and we find occasional reports of diseased plants. In the English journals, "The Garden" and "The Gardener's Chronicle," a discussion runs along through several numbers in 1895, concerning a so-called "begonia rust," which seriously affected tuberous begonias. This, however, was finally settled on good authority to be insect work. "Damping off," a fungous disease of begonia and many other kinds of seedlings, is not uncommon. Professor Halsted of the New Jersey Agricultural Experiment Station mentions two leaf-spot diseases of begonia in the "American Florist," September, 1894, one caused by nematode worms, the other a fungous disease.

During the past year or two we have met with a definite spot disease on begonias, mostly of the tuberous variety, which is quite prevalent in our houses and those of a neighboring florist. We are not yet entirely certain as to the cause of the difficulty. The spot begins either on the margin or interior of the leaf, and slowly increases in size until the leaf dies and drops off. There are sometimes several spots on each leaf. As they increase in size their surface is

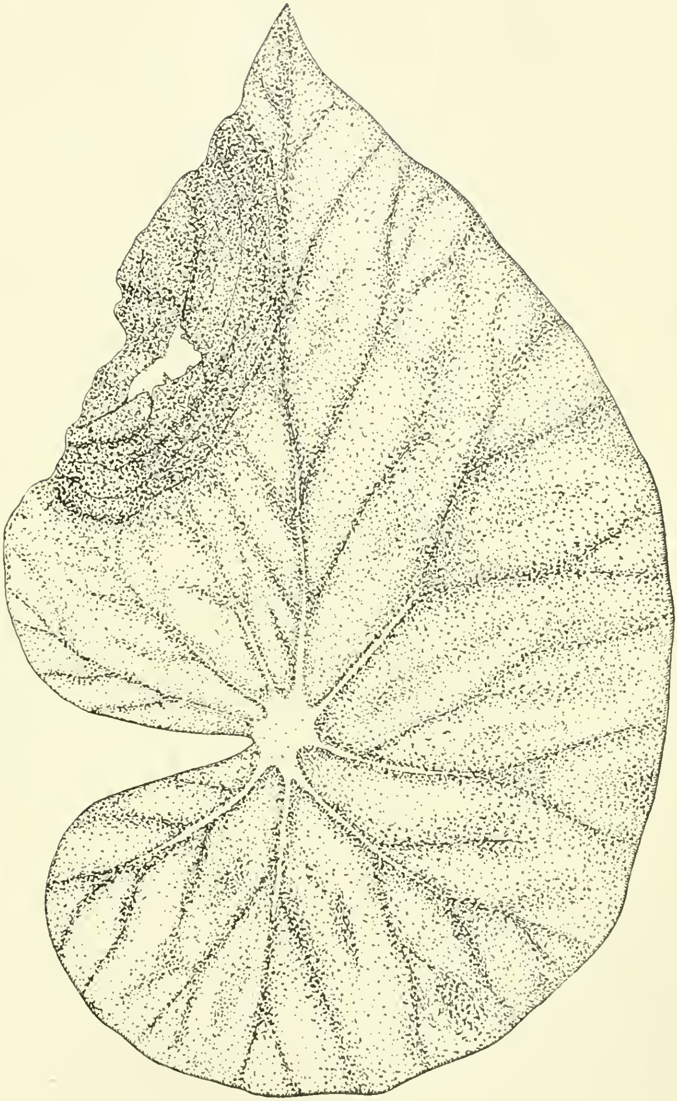

Figure 3. — Spotted Begonia leaf.

marked by concentric curved lines parallel to the edge of the dead portion, as in many spot diseases of fungous origin. Microscopic examination, however, shows nothing which may with certainty be decided upon as the cause of the trouble. We usually find fungous filaments and spores, but they are of many different species, and mostly moulds of a saprophytic or only partially parasitic nature, and cannot be regarded as the primary cause of the disease. In a few specimens we have found the spore-bearing conceptacles and spores of a fungus belonging to or near the extensive parasitic genus Glœosporium, which includes a great number of leaf spots. We consider this as the probable cause of the disease, but the spore-bearing material was very scanty, and we were unable to identify it with any described species. Possibly the trouble may be due to various causes, not all of a fungus nature, but appearances seem to indicate that there is a definite disease which causes most of the spotting. At all events, it will be a wise precaution, in this and all similar cases, to remove and burn all affected leaves.

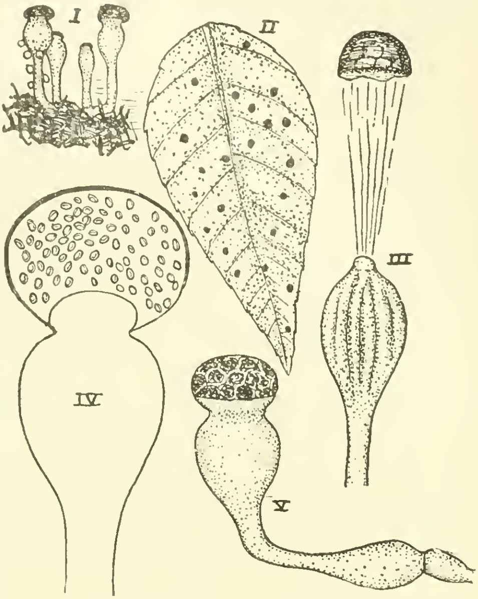

Fig. 4. — Pilobolus crystallinus, Tode.

I. Somewhat enlarged.
II. Sporangia on rose leaflet.
III. Discharge of sporangium.
IV. Section of sporangium and filament, showing spores.
V. Sporangium upon filament before being discharged.
III., IV. and V. are greatly enlarged.

Several other leaf spots of the palm, dracæna, ficus and other decorative plants have come to our notice. Some were only simple sun-burns, while others were real fungous diseases. What was at first thought to be Leptostromella elastica (the above-described leaf spot on Ficus elastica)

upon Ficus religiosus, the banyan tree, proved to be simply a sun-burn, though its superficial resemblance to the fungous disease was most perfect. Quite a serious and apparently new spot disease of greenhouse orange trees has been met with, which is of true fungous origin. It is not necessary to describe all these forms in detail, as the treatment is practically the same in each case.

A So-called Black Spot of the Rose.

(*Pilobolus crystallinus*, Tode.)

It is not unusual to find rose bushes in the greenhouse thickly dotted over with little black specks, appearing not unlike "fly specks," which occur on all parts of the plants alike, and of course greatly disfigures the blossoms. Microscopic examination shows each speck to be a minute sac, filled with what are evidently fungous spores. It would thus appear that we had here a fungous disease, and as such it has been described under several different names. In fact, however, this is in no sense a disease, and the little sacs of spores have no real connection with the rose plant, being attached to it simply by cohesion. The sacs of spores or *sporangia* are produced by a fungus, Pilobolus crystallinus, which is strictly saprophytic, and grows on decaying manure. As such manure is usually placed upon the soil under roses, spores of the Pilobolus are introduced in it, and find a favorable place for development. They produce the thread-like filaments which make up a fungous plant, and on the ends of certain of them sporangia are developed. The filament behind each sporangium becomes filled with a watery fluid, which gradually increases in quantity, and exerts a pressure on the sporangium at the end. This pressure becomes so great that finally the sporangium, at about the time of its maturity, is forced from the end of the filament with sufficient power to send it a considerable distance. We have seen them on the roof of a rose house at least eight or ten feet from the soil where they were produced. Striking a plant, they adhere to it, and give the appearance of having developed there. We find them particularly on the rose, simply because the practice of covering the soil with manure is confined to the cultivation of that plant.

While this is not a disease in any sense of the word, still, the effect of the fungus on roses is of course disastrous to their beauty and salability. Knowing that the disfiguring sporangia come from the manure, where they can readily be seen in the morning in process of development, it would seem a comparatively simple matter to destroy them at that stage, either by mechanical means or by spraying with a fungicide.

A Leaf Blight or Anthracnose of the Cucumber.

(*Colletotrichum Lagenarium* (Pass.), E. and Hals.)

During the past summer we have received specimens of cucumber leaves from several different parts of the State, which were infested with a very destructive blight. In Arlington and Leominster, where the raising of hot-house cucumbers is carried on extensively, the disease was reported as doing great damage. The fungus which causes this trouble grows within the tissues of the leaf, and by sapping its vitality causes its death. Under favorable conditions it is very quick acting and extremely destructive. The infested leaf first shows yellowish spots upon its surface, which rapidly increase in size and become dry and dead. Various moulds often develop upon the dead areas, and, being more prominent than the fungus which really produces the disease, appear to be the cause of the trouble. A dark-brown, luxuriantly growing species of Macrosporium or Alternaria was particularly abundant upon the specimens received this summer, and had evidently been taken to be the cause of the disease, which was referred to as the "brown mildew," "brown leaf blight," etc. Such growths undoubtedly hasten the destruction of the leaf, but they are able to develop only upon leaf tissue which has been killed or greatly weakened by the other more strictly parasitic fungus which is invisible to the eye. The dead areas gradually fall away, leaving large irregular holes in the leaf, which in a short time becomes entirely dead. The same fungus often attacks the fruit, causing it to rot badly, and has been proven to be the cause of the well-known "rust," so called, of the pods and leaves of the bean. It also attacks the watermelon, musk-melon, citron, squash and pumpkin, affecting both leaves and fruit. We have recommended spraying every week or two with the

Bordeaux mixture for this and one or two other somewhat similar cucumber diseases, and have received reports from Arlington of favorable results from such treatment. While this is a most destructive disease if left unchecked, it ought nevertheless to be kept under control with comparative ease if judicious spraying with any good fungicide be combined with proper management of the crop.

An Unusual Outbreak of Two Rusts.

The Asparagus Rust (*Puccinia asparagi*, D.C.).

The rust of the asparagus has been known in Europe for more than half a century, and has caused more or less damage there. In this country it has been known for several years, but not at all extensively. During the present season, however, asparagus beds in various parts of this State, in New Jersey and doubtless in other States, have been seriously attacked by this rust, and are threatened with great injury should it continue to develop extensively from year to year. This fungus is one of the true rusts, and is quite similar to that attacking the wheat. Like it, there are three distinct stages of development, in each of which a different kind of spore is produced. According to European accounts, the rust first appears on the asparagus in the spring, at which time it produces the first kind of spores, the *æcidia*. These develop in turn during the summer, and produce the spores of the second or red-rust stage, the *uredo* spores. These again develop, and produce spores of the third or black-rust stage, the *teleuto* spores, which lie over winter and in the

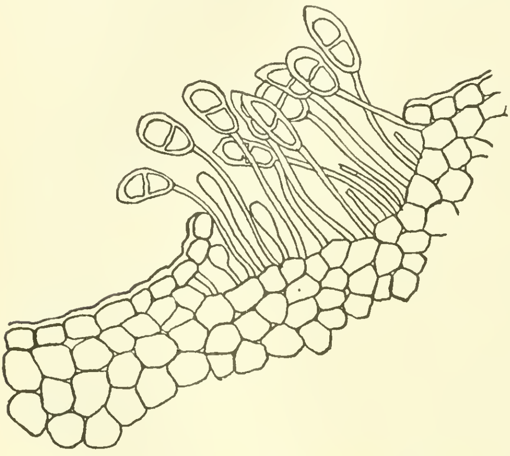

Fig. 5. — Section of a cluster of teleuto spores of *P.* asparagi, greatly enlarged.

Figure 6. — Asparagus stem with rust.

spring attack the asparagus again, and produce æcidia. In each stage the fungus consists of minute filaments, which grow in the tissue of the plant and draw their nourishment therefrom. In some rusts one of the stages is most prominent, in others it is another. In the wheat rust the uredo or red-rust stage is perhaps the most conspicuous. In the present case the black or teleuto spores are most prominent. They appear in October and November, when the affected plant becomes thickly covered over with small, irregular black lines and blotches, which are the masses of spores pushing out through the surface. This is the stage which has been observed this fall in Massachusetts and New Jersey. Doubtless the other two stages were developed during the season, but did not become sufficiently prominent to attract attention.

Since this disease does not become prominent until late in the fall, and the asparagus crop is gathered in May and June, a question naturally arises as to how it can have any serious effect. There is indeed no great danger to be apprehended of its actually disfiguring the marketable product; but no plant can undergo a continuous and vigorous attack of a parasitic fungus without a serious loss of vitality, if it be not killed outright. If this rust appears only intermittently and not extensively, its ravages need not be seriously feared; but, should it continue to develop in the present abundance year after year for any considerable time, it cannot fail to become a most serious obstacle to the raising of asparagus. Moreover, we have examples in similar rusts, like that of the hollyhock upon its first appearance in Europe and later in this country, which have developed with unusual vigor and destructiveness immediately after their first outbreak in a new locality and climate. The raising of hollyhocks in Europe was well-nigh impossible for some time after the introduction of the rust. The progress of this asparagus rust is therefore worthy of close attention and some apprehension. Meantime, attempts should be made to check it as much as possible by cleaning up the bed in the fall and burning the infested tops, thus destroying countless numbers of spores. This should be done as early as possible, before the spores shall have become mature and scattered by the wind.

A Late Rust of the Blackberry (Chrysomyxa albida, Kühn).

This rust, like that of the asparagus, has been long known in Europe, but only comparatively recently observed in this country. It was first brought to attention in America in 1886, but, while it has been not uncommon since then, it has never assumed any economic importance. Very likely it has been more or less confused with the spring orange rust (Cæoma luminatum, Lk.), which it slightly resembles, and on that account has escaped particular mention; still, it is hardly probable that it has been generally prevalent. In the season of 1894, however, it became decidedly abundant in our plantations, and caused considerable apprehension. It was also reported from other parts of the State, and threatened to become a serious matter. In 1895 it appeared again, but not so abundantly as in the previous season; and this year its attacks have been very slight, so that there seems to be no ground for fear of danger from this source at present.

Description. — This has been called the *fall* rust, to distinguish it from the *spring* rust, which appears much earlier in the season, and is entirely distinct. The latter is a well-known disease to fruit growers, as it causes much damage and has been the subject of many experiments and published articles. It attacks both blackberries and raspberries. Chrysomyxa albida comes on later, appearing in August and continuing through the fall. It does not attack the raspberry. It is one of the true rusts, having the three kinds of spores, as in the asparagus rust. In this case, however, it is the æcidia and uredo spores which are most prominent. These appear in small, powdery, scattered, bright orange-red spots on the under side of the leaf, and are consequently not as prominent as the indications of the asparagus rust.

While the same conclusions as to the future may be drawn in this case as in that of Puccinia asparagi, still, the results of three years' observation on the blackberry rust indicate that we have no great cause for alarm in that direction; while in the other case, having no such definite knowledge, we cannot but feel somewhat apprehensive until time shall show what is to be the result.

The Tomato Mildew (*Cladosporium fulvum*, Cke.).

The disease which is commonly called mildew is without doubt one of the greatest obstacles to success in growing tomatoes in the hot-house. While it does not always kill the vines outright, still, its effect in weakening their vitality and reducing their yield is a most serious one. We have received specimens of tomato leaves affected by this disease from several different localities, and have observed it in greater or less abundance in almost every house of tomatoes which we have examined. It also attacks tomatoes grown out of doors, but by no means so generally as in the hot-house.

When this disease comes on, there appear on the lower surface of the leaves brownish, felt-like spots of irregular shape and various sizes, which rapidly increase in extent, until the whole leaf finally turns black and withers away. It does not always spread so rapidly and kill the leaves at once, but is often found only on the lower leaves, or in spots which do not increase rapidly in size. Nevertheless, it is constantly weakening the plant, and, let a favorable opportunity come, as come it will sooner or later, and it spreads through the house with great rapidity and destructiveness.

The fungus consists of a dense mass of thread-like filaments, which ramify through the leaf in all directions and more or less upon its surface. The felt-like areas on the under surface of the leaves are composed of a mass of spores and the filaments which produce them. The spores germinate readily in water, developing filaments similar to those from which they were derived. This species belongs to a group of fungi which are mostly moulds and mould-like forms, growing upon dead vegetable matter or plants in a weak and unhealthy condition. This mildew is especially active in attacking such plants, upon which it produces the above-described disastrous effect. Its development is also greatly favored by excessive moisture in the air, *i. e.*, a "muggy" atmosphere, which indeed is favorable to the development of most plant diseases. The tomato requires a considerable heat for successful growth in the hot-house. If, while the plants are growing rapidly, the temperature

suddenly falls from any cause and they consequently receive a check in their growth, it will be a most favorable time for an attack of the ever-ready enemy, the mildew. Poor ventilation and partial exclusion of sunlight by crowding the vines too close together will produce a muggy atmosphere, and have a similar result. To prevent crowding, it is advisable to trim up the vines somewhat and train them to trellises or single stakes. Uniform heat, good ventilation and free access of air and sunlight to all parts of the plant will prove the most effective preventive of mildew. In our climate, however, the first two conditions are liable to prove antagonistic to each other; for in cold, windy weather it is impossible to ventilate the house without greatly reducing the temperature.

Spraying with the ordinary fungicides has proved effectual in preventing this disease. The spraying should be done about once in two weeks, commencing when the plants are quite small. It is also a wise precaution in all hot-house work to thoroughly clean up and burn all dead leaves, vines and similar materials when a crop is removed, and, if possible, fumigate the house with sulphur. The latter of course cannot be done if there are any plants growing in the house.

Too often we find that such diseases as this are allowed to develope in the house, with no effort being made to check them. So long as the plants are not killed outright, many growers seem to think that no damage is done. This is certainly not the case, for the presence of the fungus is a constant drain upon the vitality of the plant, reducing its yield both in quantity and quality. The practice of spraying, which can be done at an insignificant cost per plant, will, if properly carried out, prove both effectual and profitable.

A Crysanthemum Rust.

Specimens of diseased chrysanthemum leaves which have been sent in to the station for examination prove to be affected with one of the true rusts, the first, so far as we know, to be reported upon this host. The specimens were sent by Mr. Geo. H. Hastings of Fitchburg, Mass., who writes as follows: —

The "rust" is quite common on the chrysanthemum leaves. In the advanced stages it completely kills the leaf. It seems to me that it is a very bad enemy to fight. I had plants enough to bring seventy-five or a hundred dollars worth of flowers, and I would not sell one flower, as I did not wish to have the name of selling such flowers. The plants were grown in the garden and "lifted" about the middle of September. The rust was on the leaves at that time, and some of them were dead.

The rust was in the uredo or red-rust stage, and proved to be a form closely resembling and probably identical with Puccinia Tanaceti, S. (P. Helianthi, D. C.), which occurs commonly upon Tanacetum vulgare (tansy), several species of Artemisia (ragweed) and Helianthus (sunflower), and several other related plants. Upon these plants it sometimes acts most destructively, as it has done in this instance upon the chrysanthemum. It bids fair to become a serious obstacle to the cultivation of this valuable flower.

Experience has shown that in the development by cultivation of any plant, as it becomes changed more and more from its natural form and forced into an abnormal development, its power to resist the attacks of disease becomes diminished. For this reason reports of new diseases upon our various cultivated plants are of frequent occurrence. All such diseases are certainly not new in the sense of being caused by a kind of organism which never existed before, but only new upon some particular kind of plant, which has, by reason of its forced and abnormal development, lost the power to resist the attacks of the parasite, which has existed all along upon some other kind of plant, and very likely in a milder form.

The chrysanthemum in its present form is a comparatively new plant in this country. Its great popularity has led growers to make extraordinary efforts to force its development along certain lines, notably in size of flowers. The production of flowers eight inches in diameter by a plant destined by nature to produce them less than quarter that size cannot be accomplished without bringing about serious changes in the vital functions of the plant, and making it more susceptible to disease. Therefore the list of chrysanthemum diseases may be expected to gradually increase, as

it is now doing. At least two have been previously known. *The leaf spot* (Septoria sp. and Phyllostica sp.) was first described by Professor Halsted of the New Jersey Experiment Station several years ago, and occasions more or less damage. *The mildew* (Erysiphe Cichoracearum D. C.) has appeared more recently, and is rapidly increasing. This has a history very similar to that of the rust under consideration, being very common on Helianthus and Artemisia, as well as many other plants.

We can make no definite recommendations at present as to a treatment for this rust, it having been reported so late in the year. The true rusts are notoriously difficult to combat; the most so, perhaps, of any class of diseases. Many methods of treatment have been tried, but few with decisively profitable results. That panacea of plant diseases, the Bordeaux mixture, has been frequently recommended and tried for various rusts, with widely varying results. The same can be said of another common fungicide, the ammoniacal copper carbonate. Stewart, of the New York Experiment Station, reports, in the case of the carnation rust (Uromyces Caryophyllinus (Schrank) Schrt.), that a solution of potassium sulphide, one ounce to one gallon of water, was most effective. This strength might injure chrysanthemum leaves. One ounce to four or five gallons of water would be safer, but not, of course, as effective. With the hollyhock rust (Puccinia Malvacearum, Mont.), a very destructive disease, Mr. H. L. Frost of Arlington informs us that he has tried the Bordeaux mixture and also the commercial fungicide called "Fostite," with results in favor of the latter. It is possible, then, that some of these substances may be effective in preventing this chrysanthemum rust, but we cannot vouch for it. It would certainly be advisable to spray the plants occasionally with the Bordeaux mixture or with potassium sulphide, *commencing in the summer, when they are young and before any disease appears.* If the plants are healthy when put into the house, one or two sprayings thereafter should be sufficient to carry them through the season. All plants known to be diseased should be removed and burned.

We would urge any grower who has been troubled with

any disease of his chrysanthemums to carry on a series of experiments with various fungicides, in order to get at some idea of the best method of treatment. Without such co-operation on the part of the grower we can do but little toward remedying such a disease as this, which does not occur everywhere, and consequently can only be experimented upon wherever it may happen to break out. The same is true with many other diseases, especially those affecting various hot-house plants. If we could plant chrysanthemums and be sure of getting rust, mildew and leaf spot, and similarly with other plants, if we could be sure of getting all their diseases, then our opportunities for experiment would be unlimited; but such, of course, is not the case. While some diseases are very general, many others appear only here and there, and the opportunities for experiment are limited to those places. We will gladly aid any one as much as possible in carrying on such experiments, and will give them our personal attention so far as we may be able.

"*Drop*" *of Lettuce.*

This disease has been for the last few years the most difficult one with which the lettuce growers about Boston have had to contend. Some growers always have a large number of plants attacked, while others have it so badly that they frequently lose half the crop. The annual loss to the lettuce growers about Boston from this disease alone amounts to several thousand dollars. The effect of the disease shows itself in a single night, and it is not very difficult to detect, inasmuch as the whole plant simply collapses. It not only makes its appearance on the young plant a few weeks old, but on the mature ones as well. Lifting the diseased plant out of the soil, it shows at once that the trouble is localized in the soft, rotten stem, which is not unusually covered with fungous growths sufficiently thick to be seen with the naked eye. Examination made with the microscope reveals the presence of numerous fungous filaments ramifying throughout the stem and root. The organism causing the disease is a species of damping fungus (Botrytis), which has previously been described in the ninth annual report of this station.

Practical lettuce growers resort to various methods in order to contend with this foe, but none of them have proved wholly effectual. Most of them recognize the fact that the source of contamination is largely in the soil, and that the disease is much more troublesome in old soil than in new. This is what might be expected, especially when the old decomposing roots are left in the soil, as they often are, thus offering the most favorable conditions for the spread of the disease. As a means of controlling it, some growers have resorted to changing the soil, with beneficial results; while others make a practice of covering the surface with a layer of pure sand or yellow subsoil, about one inch in depth. The burning of sulphur in the house before a new crop is set is also practised, and this might be expected to kill the spores with which it comes in contact; but it is very doubtful whether the sulphur affects the spores in the soil to any great extent. It appears, however, that sulphur penetrates the soil somewhat, and, on account of the injury which young plants are known to receive from sulphur, they should not be set for a few days after it is used.

The disease appears to be more common than formerly, and this is partially due to the practice of running high night temperatures. The collapse of the plant is most likely to occur during the night, and with a lower night temperature — for example, one not exceeding 38° to 40°F. — the trouble would no doubt occur less frequently. The opportunities for treating the soils with chemicals do not appear to us to be very promising, for the reason that solutions which would be likely to cause the death of the fungus would have to be used in very large quantities, as well as much stronger than in ordinary cases, and they would be likely to cause injury to the crop. My experiments in applying a great variety of chemicals to the soil have shown that, while a comparatively weak solution accomplishes all that can be desired in the laboratory, when applied to the soil the effect of even much stronger solutions more copiously applied is radically different. So long as the tendency is to force crops more and more, it must be expected that the gardener will have numerous abnormal conditions to contend with.

No doubt the most successful and I believe the cheapest

method in the long run would be to apply heat as a remedy for fungus and other pests in the soil. I have used a great many pots of earth heated with steam up to 130° to 200°F., with the most beneficial results, not only in the subsequent growth of the plant, but also in destroying the troublesome pests which infest the soil. The soil under glass could be easily fitted up with a system of irrigating tile, which could be used not only for purposes of irrigation, but also for forcing steam through them and partially sterilizing the soil. I have not as yet had an opportunity of treating this fungus with heat, but I should suppose that, if the soil was heated to 200° F., it would result in its death.

Physiological Disorders.

Wilt of Maple Leaves.

Last May a number of maple leaves in a dry and crispy condition were sent to this department from various parts of the State, under the supposition that they were affected by some form of fungus or insect life. Examination of the leaves, however, by Mr. Robert A. Cooley of the insectary, showed that no form of either of these organisms could be found. All of the leaves that were sent in were those of the sugar maple (Acer saccharinum), although the same condition was observed in a large number of different varieties of Japanese maple growing on the college grounds. Moreover, they showed the wilt only on one side of the tree, namely, the west, that being the direction of the prevailing wind the day upon which they were affected; and this peculiarity — so far as could be learned — was the same all over the State. This phenomenon is especially interesting, as it occurs on apparently healthy trees under certain exceedingly unusual conditions, — conditions, too, which, lasting only a few hours, are yet capable of giving rise to abnormalties of function. We attribute the wilting of sugar-maple leaves, which occurred quite generally throughout Massachusetts on May 18, to an excessive transpiration or evaporation of water from the leaves, at a time when the water supply of the roots was extremely limited. This was brought about by a remarkable combination of meteorological conditions favorable

to this result. It is well known to vegetable physiologists that agitation of the leaves of a plant greatly accelerates the process of transpiration, that is to say, the evaporation of water from the leaves. It is also well known that transpiration is accelerated by light, a low relative humidity and a high temperature. Such were just the conditions upon May 18.* During the months of April and May the rainfall was far below the normal, while the long-continued drouths of the two preceding years will be well remembered. Thus it is evident that the supply of water available to vegetation must have been much less than usual, and under the unusually strong, dry and warm wind of May 18, the leaves of a tree like the maple, with its large leaf surface, might be expected to become greatly exhausted and wilt badly. When this wilting was not carried to excess the leaves recovered; when, however, it went too far, it resulted in a dying and subsequent shrivelling of the foliage.

Another factor which must not be overlooked in accounting for this disorder is the maturity of the foliage. Young leaves always give off the greatest amount of water, and the maple leaves in May are giving off their maximum quantity.

With plenty of water in the soil these high winds would not have caused any wilting; or, if the same conditions had ensued during August or September, when the foliage was more mature, less wilting would have resulted. The west side of the trees, being the side exposed to the prevailing winds, was the most severely affected.

Top-burn of Lettuce.

A disease occurring on greenhouse lettuce, and characterized as "top-burn" came under our observation the past winter. The disease can readily be distinguished by the withering and subsequent turning back of the tip and margin of the outer leaves, the blackened area sometimes extending inwards an inch or more from the margin. This feature greatly disfigures the plant and consequently affects its

* Meteorological conditions were as follows: total precipitation, April, 1896, 1 32 inches; April, 1895, 5.60 inches; May 1–18, 1896, .16 inch. May 18, maximum velocity of wind 71 miles per hour; relative humidity, 47.31 (average for May, 62 5); number hours sunshine, 13 (in possible 14½); maximum temperature, 84°.

market value, but the real damage to the lettuce plant is never sufficient to destroy it. Microscopic examination of the blackened areas frequently shows bacteria in the cells, but more often the "damping fungus" (Botrytis) is present, and can be readily observed with the naked eye. In this instance, however, neither of these forms of organisms has anything to do with the cause of the disease. They are simply accompanying factors, which are always ready to seize upon any abnormal condition in the plant which is especially favorable to them. The disease is a physiological one, and has its origin in the unfavorable surroundings of the plant, especially those connected with transpiration and sunlight. Mr. B. T. Galloway of the United States Department of Vegetable Physiology and Pathology has made this disease a study, and I can do no better than to quote his views: —

Top-burn, one of the worst troubles of the lettuce grower, does comparatively little injury on this soil [Boston soil], providing the proper attention is given to ventilation and the management of the water and heat. Burn is the direct result of the collapse and death of the cells composing the edges of the leaves. It is most likely to occur just as the plant begins to head, and may be induced by a number of causes. The trouble is most likely to result on a bright day following several days of cloudy, wet weather. During cloudy weather in winter the air in a greenhouse is practically saturated, and in consequence there is a comparatively little transpiration on the part of the leaves. The cells, therefore, become excessively turgid, and are probably weakened by the presence of organic acids. When the sun suddenly appears, as it often does after a cloudy spell in winter, there is an immediate rapid rise in temperature, and a diminution of the amount of moisture in the air in the greenhouse. Under these conditions the plant rapidly gives off water, and, if the loss is greater than the roots can supply, the tissues first wilt, then collapse and die. The ability of the roots to supply the moisture is affected by the temperature of the soil, the movement of water in the latter and the presence or absence of salts in solution. In this soil the temperature rises rapidly as soon as the air in the greenhouse becomes warm, and the roots in consequence immediately begin the work of supplying the leaves with water. The movement of the water in the soil is also rapid, so that the plant is able to utilize it rapidly.

While I have never seen the disease in the lettuce houses about Boston, the growers seem to be acquainted with it; and it is no doubt the superior skill which they possess that enables them to be free from it. One grower informed me that he always saturated his house with moisture in bright, sunshiny days which were preceded by cloudy weather, and by this means was able to prevent it.

REPORT OF THE ENTOMOLOGIST.

CHARLES H. FERNALD.

In the early part of 1896 the gypsy moth report mentioned last year was published by the State. This work consists of a bound volume of 608 pages, with 3 colored and 63 uncolored plates, and with 5 maps and 37 cuts in the text. The first part, comprising 263 pages, was prepared by the field director, and the second part, 244 pages, by myself, while the Appendix of 100 pages contains the reports of visiting entomologists and other papers. This work represents all that we were able to learn, up to the time of publication, of the history and habits of the notorious gypsy moth, its ravages in foreign countries as well as in our own, the means used for fighting it in other lands and also its natural enemies. Our experiments with methods for the destruction of this insect are still in progress, and occupy a large amount of time in study and work.

Quite extended studies have been carried on during the year on the spruce gall-louse (*Chermes abietis* Linn.), mainly by my assistant, Mr. R. A. Cooley, who with great care and perseverance has worked out the life history of this insect, which causes peculiar cone-like galls to form on the twigs of different varieties of spruce, rendering them unsightly and often nearly destroying them. The results of these studies are published in the thirty-fourth annual report of the college, with two plates showing the work and different stages in the life of this insect. Mr. Cooley was fortunate enough in his experiments to discover a good practical remedy for this insect, which consists in spraying the trees with a strong solution of whale-oil soap at the time these insects are in the most exposed state, which occurs during the winter or in the early spring, and also to cut off and burn the new galls in June before the insects

leave them. About five hundred circular letters were sent to all parts of the country last spring, and from the replies to these it appears that this insect already has a wide distribution in this country, and it is quite probable that in time it may become distributed wherever spruces grow.

Considerable time has been devoted to the study of cranberry insects during the summer, three trips having been made to the bogs on Cape Cod at the most favorable time for the study of these insects. There are, however, so many different species attacking the vines, and their mode of attack is so different one from another, that to learn their habits and the most effectual and economical method of destroying them forms a problem of no easy solution. We are therefore not yet ready to publish a final bulletin on these insects.

The army-worm has been unusually abundant the past year in many parts of the State, and numberless calls have been made on this department for information concerning the insect; in fact, the correspondence about the army worm during the summer was far greater than that of all other insects combined. Fortunately, we had already published a bulletin on this insect, and Mr. Kirkland, my assistant on the gypsy moth work in Malden, published an article on the army-worm in the "Crop Report" for September, 1896. It is not possible to foretell whether this insect will occur in injurious numbers next summer; but such a case would be quite unusual, as it has very rarely if ever in the past been abundant in the same locality two years or more in succession.

The elm-leaf beetle has not been so abundant in this State during the past summer as it was the year before, and this is true, as I learn, in other States. What the real cause of this decrease in numbers may be, I do not know. It may be due to a rapid increase of its vegetable parasites favored by a wet season. This, however, is all conjecture, as I have no positive evidence in the case.

The San José scale has occupied much attention; and, at the request of the president of the Shady Hill nurseries, I sent an assistant to make a critical examination of their stock at Bedford, Mass., and he reported to me that he discovered a large amount of infested stock in that nursery, which the

president promised to have burned. An examination made late this fall reveals the fact that the scale has not been entirely cleared from it. How widely this scale may be distributed in this State I am not able to say.

On the 12th of May I received a letter from L. C. Holt, Esq., of Ashby, Mass., and also a box of caterpillars which he stated were in immense quantities on the blueberry bushes, entirely stripping them of their leaves, and that unless something were done at once there would be no blueberry crop, and this would be a great misfortune, as many poor people derived quite a revenue from the berries picked from these bushes. The caterpillars proved to be the currant span worm (*Diastictis ribearia* Fitch); but the great difficulty which now presented itself was to offer some remedy which would not be as expensive as the value of the crop. I could think of no better or cheaper mode of destroying these span worms than to spray the bushes with Paris green in water, in the proportion of one pound of the former to one hundred and fifty gallons of the latter, and advised this course, if the crop was of sufficient importance to warrant the expense. This is the first time I have ever heard of this insect attacking the blueberry.

On the 17th of November I received a letter enclosing some twigs with scale insects on them from Mr. James Draper, who wrote me that they were taken from a golden-oak tree in one of the gardens of the city of Worcester, Mass. The scales proved to be what is known by the name of *Planchonia quercicola*, a European scale insect which has been in this country for some time. The first account of it here, so far as I know, was given in the report of the Department of Agriculture for 1880, page 330, where it is stated that it was found upon the imported oaks in the Department of Agriculture grounds at Washington. The insect has been found in New Jersey and also in New York, as I am informed by Professor Howard. It is regarded as a very injurious scale, and every effort should be made to destroy it by cutting off and burning the infested twigs, and thoroughly spraying the trees with whale-oil soap dissolved in water.

REPORT OF THE CHEMIST.

DEPARTMENT OF FOODS AND FEEDING.

J. B. LINDSEY.
Assistants, E. B. HOLLAND, G. A. BILLINGS,* B. K. JONES.

PART I.

LABORATORY WORK.

Outline of year's work, together with chemical investigations of a technical character.

PART II.

FEEDING EXPERIMENTS AND DAIRY STUDIES.

(*a*) Effect of narrow and wide rations upon the quantity and cost of milk and butter, and upon the composition of milk.
(*b*) Rice meal *v.* corn meal for pigs.
(*c*) Oat feed *v.* corn meal for pigs.
(*d*) Digestion experiments with sheep.

PART III.

Compilation of fodder analyses.
Compilation of fertilizer constituents of fodders.
Compilation of analyses of dairy products.
Compilation of digestion coefficients.

* Left Sept. 1, 1896.

Part I.

We have continued to analyze, free of cost, all feed stuffs, dairy products and waters sent to the station during the year. Results have been reported as promptly as possible, together with such comments as were considered necessary. There have been tested 63 samples of feed stuffs, 89 samples of whole milk, 11 samples of skim-milk, 9 samples of cream and 6 samples of butter; also 31 samples of milk and 20 samples of butter for the Dairy Bureau. These results are tabulated at the end of this report.

There have also been examined 134 samples of water, of which 10, or 7.5 per cent., were pronounced excellent; 50, or 37.5 per cent., fair; 39, or 29.1 per cent., suspicious; and 35, or 26.1 per cent., dangerous for drinking purposes.

In addition to the analyses above mentioned, which may be regarded as control work, we have made a very large number of analyses of feed stuffs, manures and milks, in connection with various animal experiments.

We have also spent considerable time in attempting to estimate some of the various substances composing the non-nitrogenous extract matter, and have compared different methods for the determination of starch in different feed stuffs, with a view of selecting one that will most correctly ascertain the true starch, when in combination with other substances of a similar nature. The results of some of the work are very briefly presented under the following heads: * —

1. *Remarks relative to the carbohydrates of agricultural plants and seeds.*
2. *Distribution of galactan.*
3. *The phloroglucin method for the estimation of pentosans.*

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* The work reported under these headings is of a technical character.

SOME REMARKS RELATIVE TO THE CARBOHYDRATES OF AGRICULTURAL PLANTS AND SEEDS.

J. B. LINDSEY.

Agricultural chemists have divided the dry matter of plants into five groups of substances, namely, crude ash, crude fibre, crude fat or ether extract, and non-nitrogenous extract matter. These terms, as is well known, do not stand for single ingredients, but rather for groups of substances having similar characteristics. The terms crude fibre and extract matter are spoken of collectively as carbohydrates. Our knowledge of the individual substances composing the fibre and extract matter has until recently been rather vague. The investigations of Tollens, Schulze and their pupils have, however, thrown considerable light, and revealed the presence and characteristics of many of the substances entering into their composition. The crude fibre of agricultural plants, as prepared by the method employed by Henneberg and Stohmann, is now known to consist principally of dextroso-cellulose (a hexa-cellulose), combined with more or less lignin or lignin acids. The fibre has also been found to contain considerable pentosan, so intimately associated with the hexa-cellulose as to be considered a penta-cellulose. Whether the penta-cellulose is actually united with the lignin as a ligno-cellulose is uncertain. The true celluloses are characterized principally by their nearly complete insolubility in dilute mineral acids and in F. Schulzes' reagent, and by their solubility in copper ammonium oxide. When cellulose is dissolved in quite concentrated sulphuric acid, and the resulting product hydrolized with dilute acid, Schulze has as a rule obtained dextrose; hence the name dextroso-cellulose. Schulze found that the cellulose obtained from wheat bran, peas and lupine seeds yielded only dextrose; that obtained from rye straw, lupine pods, spruce wood and

red clover, gave dextrose and xylose; while that prepared from the coffee bean, cocoanut and sesame cake, yielded dextrose and mannose. There exist, therefore, dextroso-, mannoso- and pentoso- celluloses. That the so-called crude fibre is not pure cellulose, but in addition to both hexa- and penta- cellulose contains more or less lignin, is probable from the fact that it is colored a bright red by phloroglucin and hydrochloric acid, and because it contains a higher percentage of carbon than pure cellulose. When the dried and finely ground plant or seed is treated according to the Weender method, a considerable portion of the lignin is split off, and reckoned as extract matter.

The term non-nitrogenous extract matter is meant to include all substances, not included within the other four groups, that are removed by means of dilute acid and alkali. In case of the grains, the extract matter is known to consist largely of starch; but when derived from coarse fodders, leguminous seeds and many by-products, its composition has been, until the investigations of Tollens and Schulze, but little understood.

To these carbohydrates that can be removed from the plant by the action of dilute mineral acid and alkali, and that are as a rule soluble in F. Schulze's reagent, E. Schulze has applied the name *hemi-cellulose*. Under this head he would bring the mother substances, dextran, levulan, mannan, galactan, araban and xylan, which yield, on inversion, the sugars dextrose, levulose, mannose, galactose, arabinose and xylose. It is the mother substances of these sugars and probably others of a similar nature not yet identified, together with ready-formed sugars, starch, and a portion of the lignin, as above alluded to, which constitute the extract matter. These hemi-celluloses are intermixed with the true celluloses and ligno-celluloses in the cell walls of plants and seeds. In some cases they have been recognized as reserve material, and are used as food in the sprouting of the seed. The levulan and mannan do not appear to be generally distributed. The araban and xylan (pentosans), on the other hand, constitute fully one-third of the extract matter of all hays and straws; they are quite prominent in the hull and bran of different grains and seeds, and are even found in the endosperm and cotyledons of many seeds.

THE DISTRIBUTION OF GALACTAN.

J. B LINDSEY and E. B. HOLLAND.

Galactan, one of the hemi-celluloses, was first extracted from lucerne seeds by Müntz,* and was converted into galactose by boiling with dilute acid. E. Schulze † and his co-workers found galactan quite prominent in the seeds of the blue lupine. The finely ground seeds were extracted with ether, alcohol, one per cent. soda solution at a low temperature to remove albuminoids, washed with water, and the residue boiled with dilute sulphuric acid. The solution was afterwards neutralized with barium carbonate, filtered, and evaporated to a syrup. This syrup was extracted with hot alcohol, and the alcoholic solution on slow evaporation yielded sugar crystals which proved to be galactose. The mother substance, yielding galactose, was also found to contain a pentose (probably arabinose). Schulze, therefore, called the substance para-galactoaraban. An examination of the pea, soy and field bean, showed the presence of the same substance. The coffee bean, date seed, palm and cocoanut cake proved the presence of galactan and mannan in liberal quantities, indicating the presence of a substance which might be termed galactomannan. Whether these substances are chemically united into complex molecules, or whether they are simple mixtures, it is hardly possible to state.

As a result of this work, Schulze assumed that the hemi-cellulose galactan might be very generally distributed in agricultural plants; and, if such should be the case, it must be of importance as a source of nutrition.

* Bull. Soc. Chim. (2) 37, p. 409.

† Zeitsch für physiol. chem. Bd 14. Heft 3; Zeitsch für physiol. chem. Bd 16, Hefts 4 and 5.

Recognizing the comparatively few fodder plants and seeds that had been tested for galactan, we thought it would prove interesting to make a quantitative estimation of the amount of the substance present in all the more important feed stuffs. While the method employed by Schulze, namely, the inverting of the galactan with dilute mineral acid and allowing the resulting sugar to crystallize out, is of course a sure proof of the presence of galactose, if properly identified, it does not admit of a *quantitative estimation* of the sugar. We therefore had recourse to the indirect method of estimating the mucic acid, as a measure of the quantity of galactose present. Scheele * was the first to recognize that by the oxidation of milk sugar, mucic acid resulted. Pasteur † found that it was the galactose of the milk sugar that yielded mucic acid. Tollens and Kent,‡ after numerous experiments, proposed the following method for obtaining the largest amount of mucic acid both from milk sugar and from galactose. They evaporated 100 grammes of milk sugar with 1,200 c.c. of nitric acid of 1.15 specific gravity in a water bath to one-third of its volume, allowed the solution to stand twenty-four hours for the mucic acid to crystallize out, then filtered onto a tared filter and dried and weighed it. This method yielded 37 to 40 per cent. of mucic acid. When pure galactose was used, a double quantity — 74–77 per cent. — was obtained.§ Rischbieth, Creydt, Hadecke and Tollens still further perfected the method, and used it in ascertaining the galactan in a variety of substances. This perfected method we have used with but slight modifications in the estimation of galactan in the substances which follow.

Method. — Three grammes of the substance were brought into a beaker about 5.5 c.m. in diameter and 7 c.m. deep, together with 60 c.c. of nitric acid of 1.15 specific gravity, and the solution evaporated to exactly one-third of its volume in a water bath at a temperature of 94 to 96 degrees C. After standing twenty-four hours, 10 c.c. of water are added to the precipitate, and it is allowed to stand another twenty-four

* Opuscula chemica et physica, Leipsig, 1789, p. 111.

† Comp. rend. 42, p. 347.

‡ Ann. Chem. 227, p. 221.

§ Landw. Versuchs-Stationen 39, p. 401.

hours. The mucic acid has in the mean time crystallized out, but is mixed with considerable material only partially oxidized by the nitric acid. The solution is therefore filtered through filter paper, washed with 30 c.c. of water, to remove as much of the nitric acid as possible, and the filter and contents brought back into the beaker. Thirty c.c. of ammonium carbonate solution * are now added, and the beaker brought into a water bath and heated gently for fifteen minutes. The ammonium carbonate takes up the mucic acid, forming the soluble muciate of ammonia. The solution is now filtered into a platinum or porcelain dish, and the residue thoroughly washed with water to remove all of the muciate of ammonia. The filtrate is then evaporated to dryness over a water bath, and 5 c.c. of nitric acid of 1.15 specific gravity are added, thoroughly stirred and allowed to stand for thirty minutes. The nitric acid decomposes the ammonium muciate, precipitating the mucic acid, which is now filtered onto a tared filter, or into a Gooch crucible, washed with 10 to 15 c.c. of water, with 60 c.c. of alcohol and quite a number of times with ether, dried at 100° C. for a short time, and weighed. The mucic acid multiplied by 1.33 gives galactose, and this multiplied by .9 gives galactan.

The method gives fairly good results, but, like other methods that are employed in estimating substances formed by physiological processes, absolute accuracy is hardly to be expected. For example, when extracting the mucic acid from the impurities with ammonium carbonate, more or less of the partially decomposed organic matter is dissolved out, which is again precipitated by the addition of the nitric acid. After the mucic acid is filtered and washed with alcohol and ether, a considerable portion of this material is dissolved out; some, however, still remains, and gives the otherwise white mucic acid a grayish color. It is possible that such a condition might be obviated by previously treating the *substance to be examined* with alcohol, ether and one per cent. soda solution in the cold, in order to remove fat, coloring matter and protein substances. Whether this could be done without loss of any of the substance is a question for further study.

* One part ammonium carbonate, 19 parts water and 1 part strong ammonia.

Results.

Coarse Fodder.

	Galactose.	Galactan.
	Per Cent.	Per Cent.
English hay,	1.01	.91
High-grown salt hay,	.93	.84
Black grass,	.71	.64
Corn stover,	.76	.68
Oat straw,	.81	.73
Rye straw,	.63	.57
Fodder millet,	.95	.86
Canada beauty pea fodder,	3.09	2.78
Medium red clover fodder,	3.73	3.36
Alsike clover fodder,	4.25	3.83
Mammoth clover fodder,	3.77	3.39

Concentrated Feeds.

Corn meal,	.05	.05
Wheat meal,	.23	.21
Oat meal,	.81	.73
Barley meal,	.55	.50
Wheat bran,	.43	.39
Millet meal,	.67	.60
Linseed meal,	1.31	1.15
Cotton-seed meal,	.63	.57
Rice meal,	1.04	.96
Rape seed,	1.07	.96
Brewers' grain,	.56	.50
Malt sprouts,	.43	.39
Dwarf horticultural bean,	.68	.61
Green soy bean,	.67	.60
Black soy bean,	.92	.83
Bush lima bean,	.79	.71
Pole lima bean,	.66	.59
Black wax bean (dwarf),	.52	.47
White pot bean,	.53	.48
Horse bean,	1.83	1.65
Canada beauty pea,	.63	.57
Prussian blue pea,	.75	.68
English gray pea,	.84	.76
Little gem pea,	1.16	1.04
Wonder pea,	1.62	1.46
Pea meal,	2.69	2.42
Vetch seed,	1.17	1.05
Serradella seed,	.66	.59
Medium red clover seed,	2.77	2.49
Mammoth clover seed,	3.63	3.27
Crimson clover seed,	3.49	3.14
Alsike clover seed,	8.96	8.06
Sweet clover seed,	6.00	5.40
White clover seed,	10.08	9.07
Alfalfa seed,	5.23	4.71
White lupine seed,	13.84	12.46
Blue lupine seed,	16.29	14.66

Many of the substances tested show less than one per cent. of galactan, and we are not certain in many cases, because of the small amount of precipitate obtained, whether the material weighed really was mucic acid or partially decomposed organic matter. All substances, therefore, containing less than one per cent. of galactan, may be for the present characterized as doubtful. To settle the presence or absence of very small amounts of galactan, we shall either be obliged to still further perfect the method, or work with larger quantities. Tollens states that mucic acid melts at 213 degrees C. We have tested the melting point of the precipitate in cases when there was sufficient present, and found a melting point of about 215 degrees C.

The results as given above show the presence of very small amounts of galactan in the non-leguminous coarse fodders and seeds. In the leguminous plants from three to four per cent. are present, while in case of the leguminous seeds, several varieties of beans and peas appear to contain very limited quantities, but the larger number of such seeds tested show from 1½ to as high as 14 per cent. With the exception of the lupines, the clover seeds contain the largest amounts, the seeds of white variety containing 9 per cent.

The above results are merely a report of progress. They show, however, that the galactans are not as widely distributed nor present in such large quantities as are the pentosans, and therefore do not play such an important part as do the latter in the process of nutrition. We propose to continue the investigation of the distribution of these substances, and also to determine their digestibility.

THE PHLOROGLUCIN METHOD FOR THE ESTIMATION OF PENTOSANS.

J. B. LINDSEY and E. B. HOLLAND.

Councler * has suggested that, instead of phenylhydrazin, phloroglucin be employed for the precipitation and estimation of furfurol obtained by the distillation of various substances, with dilute hydrochloric acid. Kruger and Tollens † have further studied and perfected the method, and recommended it as reliable for the estimation of pentosans in various coarse fodders, grains and vegetables.

The phloroglucin, like the phenylhydrazin method, is based on the fact that the pentosans (araban, xylan, etc.) differ from other carbohydrates in that they yield furfurol instead of levulinic acid upon digestion with moderately dilute hydrochloric or sulphuric acids. The first step necessary in both processes for a quantitative estimation is the conversion of the pentosans into furfurol and its separation from the resulting by-products.

Phloroglucin Method described.

Three grammes of the material are brought into a ten-ounce flask, together with 100 c.c. of 12 per cent. hydrochloric acid (specific gravity, 1.06), and several pieces of recently heated pumice stone. The flask, placed upon wire gauze, is connected with a Liebig condenser, and heat applied, rather gently at first, and so regulated as to distil over 30 c.c. in ten to fifteen minutes from the time that boiling begins. The 30 c.c. driven over are replaced by a like quantity of the dilute acid, by means of a separatory funnel; and the process so continued as long as the distillate gives a pronounced reaction with aniline acetate on filter paper (a

* Chemikerztg, 1894, No. 51. † Zeitsch. für Ang. Chem., 1896, Heft II.

few drops of aniline in a little 50 per cent. acetic acid). To the completed distillate is gradually added a quantity of phloroglucin * dissolved in 12 per cent. hydrochloric acid, and the resulting mixture thoroughly stirred. The solution first turns yellow, then green; and very soon an amorphous greenish precipitate appears, which grows rapidly darker, till it finally becomes almost black. The solution is made up to 500 c.c. with 12 per cent. hydrochloric acid, and allowed to stand over night. In case there is very little furfurol in the substance tested, and the resulting distillate consequently small, it is best to add sufficient 12 per cent. hydrochloric acid to the distillate before adding the phloroglucin solution, so that, upon the addition of the latter solution, the resulting mixture will contain approximately 500 c.c.

The amorphous black precipitate is filtered into a tared Gooch crucible through an asbestos felt, washed with 100 c.c. of water, dried to constant weight by heating three to four hours at 100 degrees C., cooled and weighed, the increase in weight being reckoned as phloroglucid. To calculate the furfurol from the phloroglucid,† use the following table: —

TOTAL WEIGHT OF PHLOROGLUCID OBTAINED.	Divided by, equals Furfurol.	TOTAL WEIGHT OF PHLOROGLUCID OBTAINED.	Divided by, equals Furfurol.
.20 gramme, . .	1.820	.34 gramme, . .	1.911
.22 " . .	1.839	.36 " . .	1.916
.24 " . .	1.856	.38 " . .	1.919
.26 " . .	1.871	.40 " . .	1.920
.28 " . .	1.884	.45 " . .	1.927
.30 " . .	1.895	.50+ " . .	1.930
.32 " . .	1.904		

Furfurol ÷ by grammes substance taken × 1.84 = pentosans.
Furfurol ÷ by grammes substance taken × 1.65 = xylan.
Furfurol ÷ by grammes substance taken × 2.03 = araban.

* Dissolve twice as much dry phloroglucin as furfurol expected in about 50 c.c. of 12 per cent. hydrochloric acid. Bring the hydrochloric acid into a water bath, and stir thoroughly till the phloroglucin goes into solution.

† The phloroglucid is a complex substance, of uncertain formula. It contains 63 to 64 per cent. of carbon and from 3.6 to 4.2 per cent. of hydrogen. The factors for calculating the amount of furfurol from the phloroglucid were obtained after experimenting with known amounts of pure furfurol and phloroglucin.

The amount of pentosans was estimated by both the phenylhydrazin and the phloroglucin methods in the following substances: —

	Phenylhydrazin Method (Per Cent.).	Phloroglucin Method (Per Cent.).
English hay,	21.28	22.50
High-grown salt hay,	25.64	25.74
Branch grass,	24.65	26.43
Low meadow fox grass,	27.98	27.91
Buffalo gluten feed,	16.45	16.00
Lupine seeds,	9.42	9.64

With two exceptions the two methods show very closely agreeing results. We propose to still further compare these methods in the near future. The phloroglucin method, on account of its greater simplicity, is much to be preferred.

Part II.

(*a*) THE EFFECT OF NARROW AND WIDE RATIONS ON THE QUANTITY AND COST OF MILK AND BUTTER, AND ON THE COMPOSITION OF MILK.

J. B. LINDSEY, E. B. HOLLAND and GEO. A. BILLINGS.

Results of Two Experiments.

I. Definition: By narrow ration is meant one containing 4 to 5 times as much carbohydrates as protein (1 : 5); by wide ration one containing 8 to 10 times as much carbohydrates as protein (1 : 10).

II. The same amount of digestible matter in narrow rations produced from 11.8 to 12.9 per cent. more milk than did a like amount of digestible matter in wide rations; narrow rations also reduced the cost of production from 5 to 12 per cent.

III. The average cost of a quart of milk produced with the narrow rations was 1.81 cents, and with the wide rations 1.97 cents.

IV. The narrow rations produced over the wide rations practically the same relative increase in the amount of butter and the same decrease in the cost of production as in the case of the milk.

V. The narrow rations produced butter at a cost of 15.57 cents per pound, and the wide rations at a cost of 16.52 cents per pound.

VI. In Experiment I., with the narrow rations, the best cow produced 12.2 pounds of butter in a week, at a cost of 14 cents per pound; and the poorest cow produced 8.26 pounds, at a cost of 19.37 cents per pound. In the same experiment, with the wide ration, the best cow produced 9.52 pounds, at a cost of 16.67 cents per pound; and the poorest cow produced 7.28 pounds, at a cost of 18.88 cents per pound.

In Experiment II., on the narrow ration, the best cow produced 12.81 pounds of butter per week, at a cost for feed consumed of 11.66 cents; and the poorest cow 7.98 pounds, at a cost of 15.90 cents per pound. With the wide ration, the best cow produced 10.92 pounds per week, costing 12.71 cents; and the poorest cow 6.86 pounds, costing 16.21 cents per pound.

VII. In these two experiments narrow rations produced manure having 20 per cent. more fertilizing value than that produced by wide rations. In general, it can be said that narrow rations produce manure containing 10 to 15 per cent. more fertility than wide rations.

VIII. Neither the narrow nor wide ration produced any decided change in the composition of the milk.

IX. For total consumption of dry and digestible matter; total yields of milk, milk solids and fat; pounds of milk, milk solids and fat produced by 100 pounds of dry and digestible matter; and for digestible matter required to produce 100 pounds of milk, 1 pound of milk solids and 1 pound of butter,— see tables XII., XIII. and XIV., in rear of this report.

A. Methods employed in carrying out the Experiments.

Plan.

The experiments were two in number, and were conducted during the autumn and winter of 1895–96, with six cows. The animals were divided as evenly as possible into two lots, and the experiments were so arranged that in the first half of each experiment three of the cows were fed the narrow rations while the other three were receiving the wide rations; in the second half of the experiment the order was reversed. In this way the natural milk shrinkage as well as the natural change in the quality of the milk was equalized. In the first experiment the two halves each lasted twenty-six days, and at least seven days were allowed after the animals were placed upon the full ration before the actual test began. In Experiment II. the halves each lasted twenty-one days.

History of Cows.

NAME.	Breed.	Age.	Last Calf dropped.	Milk Yield at Beginning of Experiments.	
				I.	II.
		Years.		Pounds.	Pounds.
I. Ada, ...	Grade Ayrshire, .	7	Oct. 1,	26	22
II. Una,*	Native, ...	10	Sept. 1,	22	-
II. Guernsey,† . .	Grade Guernsey, .	7	Dec. 1,	-	30
III. Bessie, . . .	Grade Ayrshire, .	7	Sept. 10,	27	26
IV. Beauty, . . .	Grade Jersey, . .	5	Sept. 15,	27	20
V. Red, ...	Grade Durham, . .	7	Oct. 8,	33	27
VI. Spot, ...	Grade Durham, . .	7	Oct. 8,	34	27

* Used in first experiment. † Used in second experiment.

The animals had been purchased in the neighborhood, at an average cost of $50 each, when fresh. They were better animals than the average, and most of them had been dry for several months before calving, so that they would naturally be able to do their best work during the two experiments now being described. None of the animals had been served at the beginning of the experiment, but they were allowed to take bull later. Most of them were served between the two halves of the first experiment.

Feeds and Feeding.

In the first experiment all of the cows were fed hay and sugar beets as coarse feeds. In the wide ration half, each cow had one pound more of hay daily than in the narrow ration half, in order to make up a like amount of total digestible daily nutrients. Chicago gluten meal and wheat bran were fed in the narrow ration, and corn meal and wheat bran in the wide ration. The hay was quite coarse, and consisted of Timothy, with an admixture of clover. Cow II. left a small quantity of the coarser portion in one half, which was deducted from the amount consumed in calculating the digestible daily nutrients eaten.

In the second experiment the coarse feeds consisted of hay, and millet and soy bean ensilage; the concentrated feeds in case of the narrow ration were bran, Chicago gluten

meal and old-process linseed meal; and in case of the wide ration, wheat bran and corn meal. In this experiment the feeds were entirely consumed.

The feeds were very carefully weighed out, and given twice daily. Water was kept before the animals constantly, by means of the Buckley self-watering device. A cover swung upon hinges kept the feed from getting into the water. The animals very soon learned to lift the cover whenever they desired to drink.

Sampling the Feeds.

A small sample of the different grain feeds was taken daily, and preserved in glass-stoppered bottles; a sample of the hay was taken weekly, and likewise preserved; and at the end of each of the two halves of each experiment dry-matter determinations were made and samples preserved for analysis. In case of the sugar beets and ensilage, samples were taken weekly and tested for dry matter at once, and at the close of the experiment these several samples were mixed and preserved for analysis.

General Care.

The cows were milked twice daily, about five o'clock in the morning and five in the afternoon, always by the same attendant, who was a graduate of the college, and thoroughly trustworthy. The animals were carded daily, and allowed the run of a yard in pleasant weather. They were given plenty of stall room, and made as comfortable as possible. The wing of the stable in which they were confined contained no storage room, and each animal was allowed fully 1,200 cubic feet of air. The wing was heated with hot water, and kept at a temperature of 50 to 55 degrees F. during the winter months. Ventilation was secured by means of a shaft 8 by 15 inches, placed at the south end of the wing, running to within 1 foot of the floor, and extending 12 feet above the roof, terminating in a so-called Archimedean ventilator. In the shaft was placed a hot-water coil, to increase the draught. Air was admitted by means of windows opening into the barn, thus avoiding direct draughts. The windows were sufficient in number to keep the barn fully lighted.

Weighing the Animals.

The animals were weighed before feeding in the afternoon at the beginning and end of the experiment, and once a week during its continuance. It is recognized that this was not sufficient, and in experiments now being made the animals are weighed for three successive days at the beginning and end of the experiment and the same number of times weekly during its continuance.

Care of the Milk.

The milk was weighed at once after being drawn, on a Chatillon balance sensitive to two ounces. Composite samples were taken for five days of each week, the milk being preserved with the aid of bichromate of potash. In order to secure an average sample, it was poured from one pail to another three times, and then 10 c.c. removed with the aid of a pipette, an exact amount being taken at every milking. The glass jars containing the composite samples were kept tightly covered, and were gently rotated each day, to prevent any undue clotting of the cream.

Testing the Milk.

The tests were in all cases made in duplicate. The total solids were made either by the sand method or by use of the perforated disk filled with asbestos. The fat was determined by the gravimetric method, and in case of Experiment II. total nitrogen was estimated by the Kjeldahl method.

Experiment I.

DATES OF EXPERIMENT.	Narrow Ration.	Wide Ration.
October 24 through November 18, ...	Cows I., IV., VI.	Cows II., III., V.
November 28 through December 23, . . .	Cows II., III., V.	Cows I., IV., VI.

Experiment II.

January 27 through February 16, ...	Cows I., II., VI.	Cows III., IV., V.
February 29 through March 20, ...	Cows III., IV., V.	Cows I., II., VI.

B. Rations consumed, and their Effect on the Quantity and Cost of Milk and Butter.

Average Daily Rations fed to Six Cows (Pounds).

Experiment I.

CHARACTER OF RATION.	Wheat Bran.	Chicago Gluten.	Linseed Meal.	Corn Meal.	Hay.	Sugar Beets	Millet and Bean Ensilage.
Narrow ration,	3	5.83	–	–	15.17	12	–
Wide ration,	3	–	–	5.83	16.17	12	–

Experiment II.

CHARACTER OF RATION.	Wheat Bran.	Chicago Gluten.	Linseed Meal.	Corn Meal.	Hay.	Sugar Beets	Millet and Bean Ensilage.
Narrow ration,	2.83	3 00	1.92	–	10.33	–	28.33
Wide ration,	1.92	–	–	5.83	10.33	–	28.33

Average Weight of Animals and Total Digestible Nutrients in Daily Rations (Pounds).

Experiment I.

CHARACTER OF RATION.	Weight of Animal.	Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
Narrow ration,	941	3.07	.59	10.23	14.06	1:3.86
Wide ration,	938	1.46	.52	12.45	14.43	1:9.43

Experiment II.

CHARACTER OF RATION.	Weight of Animal.	Protein.	Fat.	Carbohydrates.	Total.	Nutritive Ratio.
Narrow ration,	899	2.85	.65	9.96	13.46	1:4.04
Wide ration,	890	1.45	.54	11.44	13.42	1:8.85

The difference between the two rations in Experiment I. consists in the fact that gluten meal high in protein was substituted for corn meal low in protein. In Experiment II.

gluten and linseed meals were substituted for corn meal. It might have been better had the coarse feeds been increased somewhat, in order to have raised the total digestible nutrients to 15 pounds daily. The animals, however, maintained very even average weights during both experiments. In both halves of each experiment the total digestible nutrients were practically the same.

TABLE I. — *Yield and Cost of Milk.*

Experiment I. 26 Days (6 Cows).

CHARACTER OF RATION.	Total Yield (Pounds).	Average Daily Yield.		Total Cost of Feed consumed.	Cost of Feed to produce a Quart of Milk (Cents).	Cost of Feed to produce 100 Pounds of Milk (Cents).
		Quarts.	Pounds.			
Narrow,	4241.5	12.65	27.2	$36.84	1.89	87.0
Wide,	3695.5	11.03	23.7	35.34	2.11	95.7
Increase narrow over wide ration,	546.0	1.62	3.5	1.50	—.22	—8.7
Percentage increase,	12.9	-	-	-	—11.70	-
Experiment II. 21 Days (6 Cows).						
Narrow,	3261.0	12.01	25.82	$26.27	1.74	80.6
Wide,	2877.0	10.58	22.73	24.43	1.83	84.9
Increase narrow over wide ration,	384.0	1.43	3.03	1.84	—.09	-
Percentage increase,	11.8	-	-	-	—5.20	-

The above table shows that the narrow rations produced from 11.8 to 12.9 per cent. more milk than did the wide rations, and that they reduced the cost of production from 5 to 12 per cent. At the end of Experiment II., six months after calving, the cows were averaging between 11 and 12 quarts of milk daily.* It was not the primary object of these two experiments to select the most economical feeds for milk production, but rather to note the effect of narrow *v.* wide rations on the *quality* of the milk. The figures, however, cannot fail to prove interesting to the milk producer.

* Cow No. 2, at the close of Experiment II., had been calved but three months.

TABLE II. — *Yield and Cost of Butter.*

Experiment I. 26 Days (6 Cows).

CHARACTER OF RATION.	Total Yield of Butter Fat.	Equivalent to Butter.	Average Daily Yield.	Average Weekly Yield.	Average Cost of Feed per Pound of Butter produced.
	Pounds.	Pounds.	Pounds.	Pounds.	Cents.
Narrow, ...	190.90	222.71	8.55	59.85	16.74
Wide, ...	164.87*	192.01	7.11	49.77	18.41
Increase narrow over wide ration,	26.03	30.70	1.44	10.08	—1.67
Percentage increase, . . .	13.70	13.70	-	-	—10.00

Experiment II. 21 Days (6 Cows).

Narrow, ...	157.69	183.98	8.75	61.25	14.40
Wide, ...	144.56	168.64	8.01	56.07	14.64
Increase narrow over wide ration,	13.13	15.34	.74	5.18	—.24
Percentage increase, . . .	8.30	8.30	-	-	—1.67

The figures tell the same story as they did in the yield of milk. On the narrow rations the cows produced 13.7 per cent. more butter in Experiment I. and 8.3 per cent. more in Experiment II. than they did on the wide rations. In Experiment I. the cost of feed per pound of butter produced was 16.74 cents for the narrow ration and 18.41 cents for the wide ration, showing that the narrow ration produced butter for 10 per cent. less per pound than did the wide ration. In Experiment II. the cost of feed per pound of butter produced was 14.57 cents for the narrow and 14.64 cents for the wide ration, showing a difference of but 1.67 per cent. in favor of the narrow ration.

It is of course impossible to state with accuracy the exact cost of feed required to produce a pound of butter, as so

* Cow V. (Red) during a portion of this period produced milk with but 2.85 per cent. of fat, and then suddenly increased to 4 per cent. The above figures include this cow's production on the basis of 4.05 per cent. fat for the entire period; otherwise the percentage increase of the butter in the narrow ration would be more than the percentage increase in the milk produced, which might lead to the supposition that the narrow ration had actually increased the percentage of fat in the milk, when really this sudden increase of fat was entirely independent of the influence of the feed.

much depends upon the cost of feeds used, character of the cows, and the stage of lactation. The figures simply show what six of the better class of ordinary cows that had been well fed were able to do, during the first six months after calving.

TABLE III. — *Yield and Cost of Butter from Poorest and Best Cows.*

CHARACTER OF COW AND RATION.	EXPERIMENT I.			EXPERIMENT II.		
	Daily Yield.	Weekly Yield.	Cost of Feed per Pound.	Daily Yield.	Weekly Yield.	Cost of Feed per Pound.
	Pounds.	Pounds.	Cents.	Pounds.	Pounds.	Cents.
Best cow, narrow,	1.74	12.20	14.00	1.83	12.81	11.66
Poorest cow, narrow,	1.18	8.26	19.37	1.14	7.98	15.90
Best cow, wide,	1.36	9.52	16.67	1.56	10.92	12.71
Poorest cow, wide,	1.04	7.28	18.88	.98	6.86	16.21

In Experiment I. the best cow on the narrow ration produced 12.2 pounds of butter per week, at a cost for feed consumed of 14 cents per pound; while the poorest cow produced 8.26 pounds, at a cost of 19.37 cents per pound. In the same experiment on the wide ration one cow produced 9.52 pounds per week, costing 16.67 cents per pound; and another 7.28 pounds per week, costing 18.88 cents.

In Experiment II. the best yield with the narrow ration was 12.81 pounds of butter per week, costing for feed eaten 11.66 cents per pound; and the poorest yield was 7.98 pounds, costing 15.90 cents. In the same experiment on the wide ration the best yield was 10.92 pounds weekly, costing 12.71 cents per pound; and the least yield 6.86 pounds weekly, costing 16.21 cents per pound. One is enabled from the above figures to note both the influence of the cow and the cost of the daily ration upon the cost of the butter produced. The cow yielding 12.81 pounds weekly, at a cost of 11.66 cents per pound for food consumed, was a grade Guernsey, fresh at the time. Her general form and appearance would not indicate that she was more than a very ordinary cow. She produced about 14 quarts of milk daily when at her best, containing 5.3 per cent. of butter fat. Such facts as the above ought certainly to stimulate farmers to ascertain the amount and quality of the milk produced by

their cows during a period of lactation. Only by such a course can the unprofitable cows be weeded out, and the herd brought to a higher standard. The scales and the Babcock tester are necessary; mere guess will not accomplish it.

TABLE IV. — *Approximate Estimate of the Amount and Value of Fertilizer Constituents in Excretions of the 6 Cows.*

CHARACTER OF RATIONS.	Nitrogen (Pounds).	Phosphoric Acid (Pounds).	Potash (Pounds).	Relative Values of Same.
Average of Experiments I. and II., narrow, .	153	35	79	$28 65
Average of Experiments I. and II., wide, . .	108	40	95	22 95
Percentage increased value of narrow over wide ration, .				$19 20

For the sake of comparison, by figuring the value of the nitrogen, phosphoric acid and potash contained in the feeds consumed (less 20 per cent. for the amount retained in the system or otherwise lost) by the market cost of these several ingredients per pound, it will be seen that the manure from the narrow ration has 20 per cent. more value than that from the wide ration. The cause of the increased value lies naturally in the increased amount of nitrogen present. In case of the rations fed in these experiments, the fact that the wide ration has more potash than the narrow is because gluten meal, which served to increase the protein, contains but minimum amounts of this ingredient. If cotton or linseed meal had been used in place of the gluten meal, the reverse would have been true. While the so-called narrow rations as used in these experiments were extreme ones, it might be said that narrow rations which contain from 2 to 2½ pounds of digestible protein in a day's feed, aside from their causing a 10 per cent. increase in the milk yield, furnish in addition a manure from 10 to possibly 15 per cent. more valuable than do wide rations.

While narrow rations will unquestionably produce more milk and butter than wide rations, the relative cost of the milk and butter produced by the two rations will depend

upon the price of the concentrated feed stuffs. The markets, however, at the present time contain such a great variety of these products that the feeder can select those rich in protein at prices that will enable him to feed the narrow or so-called well-balanced rations to advantage.

In the closing remarks on this portion of the experiment, it is well to inquire what are to be considered as economical narrow rations. The German ration established so long ago by the late Emil von Wolff contained, for cows of 1,000 pounds weight, 2.5 pounds of digestible protein, .5 pounds of digestible fat and 13 pounds of digestible carbohydrates, with a proportion of protein to fat and carbohydrates of 1 to 5.4.

The writer is convinced that 2.5 pounds of digestible protein daily is amply sufficient, and seriously questions whether it is not too much. More than this amount, or even 2.5 pounds daily in the form of concentrated feed stuffs, if fed from eight to nine months each year, will soon tend to impair the milk-producing capacity of the cow. Some cows might be able to withstand such feeding longer than others. It might be advisable, for economic reasons, to feed as high as 3 pounds of digestible protein daily to average cows for two or three years, and then turn them into beef; but cows possessing more than ordinary merit should be differently handled. It should ever be kept in mind that it is far better to breed and select cows that possess extra milk and butter qualities than to attempt to attain those ends by extra amounts of concentrated feeds.

The amount of protein, as well as the amount of total digestible organic nutrients, that can be fed in the daily ration in order to produce milk and butter at low prices, and at the same time not impair the milk-producing organs by overwork, is still an uncertain quantity; and in order to secure more accurate information, taking into consideration American conditions, extended and carefully conducted investigations are necessary. Such experiments should be carried out only by those who can control all the conditions, who thoroughly understand the nature, handling and care of animals, and who have the time to give the experiments a close personal attention.

C. The Effect of Narrow and Wide Rations on the Quality of the Milk.

Many experiments have been published and many opinions expressed relative to the effects of single feeds and feed combinations on the quality of milk. The writer has briefly reviewed the most important of these experiments elsewhere.* W. H. Jordan † has recently also presented a most excellent review and critical examination of such experiments.

Practically all of the experiments thus far made have taught that feeds have but very little influence on the quality of milk. By "affecting the quality" is meant the increasing and decreasing of any or all of the solid constituents of the milk, such as casein, albumin, milk sugar, fat and ash. It is a commonly recognized fact that some feeds affect the flavor of milk, and to a slight extent its color, also possibly its acidity and alkalinity. It is possible that feeds and feed combinations rich in fat have a tendency to slightly increase the percentage of fat in the milk of some cows. Whether or not feeds rich in protein have a similar tendency, is still uncertain. It is probable that this increase is only of a temporary character, the milk gradually coming back to its normal condition. Animals very thin in flesh and insufficiently fed, if brought into good condition by proper feed, will probably show an increase in one or all of the solid constituents. This improvement will certainly not be very marked. It is possible that the improvement in the milk brought about by the more complete nourishment of a thin and insufficiently fed animal consists more in an improvement in the *quality* of the fat, or nitrogenous matter, than in increasing to any marked degree their actual percentages in the milk. The quality of milk varies, as is well known, during the different stages of lactation, but this is entirely independent of the influence of feed.

In conducting experiments of this character the investigator should be very careful that he is able to control all the conditions liable to in any way affect the results. The milk-

* Twelfth report of Massachusetts Experiment Station, 1894.

† Agriculture of Maine, 1895, page 139.

producing organs are largely under the control of the nervous system, and any sudden change disturbing the nervous temperament of the animal, such as a sudden extreme change of temperature, an angry man, change of milkers, etc., is very likely to have an effect on the quality of her product. This can easily be observed by testing the milk daily and noting the variations, especially in the percentage of fat. Too short periods render such experiments valueless, as well as changing the entire daily character of the feed in two or three parts of a single experiment. No greater mistake can be made than in employing cheap, unreliable help. The results of many of the experiments thus far made along this line of investigation are of absolutely no value, because one or several improper influences have not been controlled by the experimenter.

In the two experiments which follow, the experimenter has sought as far as possible to prevent any influence other than the one desired to have any bearing on the results. The methods have been described under A. The complete feeding record of each cow will be found at the end of this article.

TABLE V. — *Showing Composition of the Milk.*

		COWS.																	
		ADA (1).						UNA * OR GUERNSEY † (2).						BESSIE (3).					
		Total Solids (Per Cent.).	Nitrogen (Per Cent.).	N.×6.25 = Nitrogenous Matter (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Proportion of Fat to Solids not Fat	Total Solids (Per Cent.).	Nitrogen (Per Cent.).	N.×6.25 = Nitrogenous Matter (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Proportion of Fat to Solids not Fat.	Total Solids (Per Cent.).	Nitrogen (Per Cent.).	N.×6.25 = Nitrogenous Matter (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Proportion of Fat to Solids not Fat.
EXPERIMENT I.	Narrow ration, .	12.92	-	-	4.24	8.68	1:2.05	14.34	-	-	4.53	9.81	1:2.17	13.34	-	-	4.36	8.98	1:2.06
		12.83	-	-	4.07	8.76	1:2.15	14.50	-	-	4.68	9.82	1:2.10	13.37	-	-	4.36	9.01	1:2.07
		13.03	-	-	4.11	8.92	1:2.17	13.78	-	-	4.15	9.63	1:2.32	13.10	-	-	4.22	8.88	1:2.10
	Average, . .	12.93	-	-	4.14	8.79	1:2.12	14.21	-	-	4.45	9.75	1:2.20	13.27	-	-	4.31	8.96	1:2.08
	Wide ration, .	13.13	-	-	3.96	9.17	1:2.32	13.54	-	-	4.12	9.42	1:2.29	12.82	-	-	4.22	8.60	1:2.04
		13.30	-	-	4.20	9.10	1:2.17	13.87	-	-	4.35	9.52	1:2.19	12.60	-	-	4.22	8.36	1:1.97
		13.14	-	-	4.22	8.92	1:2.11	14.25	-	-	4.82	9.43	1:1.96	12.88	-	-	4.16	8.72	1:2.10
	Average, . .	13.19	-	-	4.13	9.06	1:2.20	13.89	-	-	4.43	9.46	1:2.14	12.77	-	-	4.21	8.56	1:2.04
EXPERIMENT II.	Narrow ration, .	13.25	.497	3.11	4.26	9.02	1:2.12	14.50	.511	3.19	5.35	9.15	1:1.71	13.58	.509	3.18	4.78	8.80	1:1.84
		13.11	.493	3.08	4.41	8.70	1:1.97	14.30	.503	3.14	5.39	8.91	1:1.67	13.36	.508	3.17	4.58	8.78	1:1.92
		13.24	.497	3.11	4.25	8.99	1:2.11	14.25	.501	3.13	5.25	9.00	1:1.71	13.55	.522	3.26	4.60	8.95	1:1.95
	Average, . .	13.21	.496	3.10	4.31	8.90	1:2.07	14.35	.505	3.15	5.33	9.02	1:1.70	13.50	.513	3.20	4.65	8.85	1:1.90
	Wide ration, .	13.41	.510	3.18	4.31	9.10	1:2.11	14.48	.526	3.29	5.30	9.18	1:1.73	13.98	.518	3.23	4.88	9.10	1:1.86
		13.49	.511	3.19	4.49	9.00	1:2.01	14.43	.499	3.11	5.53	8.90	1:1.61	14.21	.498	3.11	5.28	8.93	1:1.79
		13.50	.512	3.20	4.41	9.09	1:2.06	14.62	.508	3.17	5.63	8.99	1:1.60	14.05	.489	3.05	5.07	8.98	1:1.77
	Average, . .	13.47	.511	3.19	4.40	9.07	1:2.06	14.51	.511	3.19	5.49	9.02	1:1.65	14.08	.502	3.13	5.08	9.00	1:1.80

* In Experiment I.

† In Experiment II.

TABLE V. — *Concluded.*

		COWS.																	
		BEAUTY (4).						RED (5).						SPOT (6).					
		Total Solids (Per Cent.).	Nitrogen (Per Cent.).	N.×6.25 = Nitrogenous Matter (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Proportion of Fat to Solids not Fat	Total Solids (Per Cent.).	Nitrogen (Per Cent.).	N.×6.25 = Nitrogenous Matter (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Proportion of Fat to Solids not Fat.	Total Solids (Per Cent.).	Nitrogen (Per Cent.).	N.×6.25 = Nitrogenous Matter (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Proportion of Fat to Solids not Fat
EXPERIMENT I.	Narrow ration, .	13.98	-	-	4.75	9.23	1:1.94	12.68	-	-	4.02	8.66	1:2.15	14.15	-	-	5.00	9.15	1:1.83
		14.68	-	-	5.19	9.49	1:1.83	12.86	-	-	4.18	8.68	1:2.08	14.17	-	-	4.81	9.36	1:1.94
		14.80	-	-	5.32	9.48	1:1.78	12.58	-	-	3.90	8.68	1:2.23	14.68	-	-	5.30	9.38	1:1.77
	Average, . .	14.40	-	-	5.09	9.40	1:1.85	12.71	-	-	4.03	8.68	1:2.15	14.33	-	-	5.04	9.29	1:1.84
	Wide ration, .	14.92	-	-	5.11	9.81	1:1.92	11.33	-	-	2.85	8.48	1:2.98	14.35	-	-	4.79	9.56	1:2.00
		14.89	-	-	5.13	9.76	1:1.90	11.10	-	-	2.97	8.13	1:2.74	14.80	-	-	5.22	9.58	1:1.83
		14.64	-	-	4.98	9.66	1:1.95	12.33	-	-	4.05	8.28	1:2.05	14.00	-	-	4.85	9.15	1:1.89
	Average, . .	14.82	-	-	5.07	9.75	1:1.92	12.33	-	-	4.05	8.28	1:2.05	14.38	-	-	4.95	9.43	1:1.91
EXPERIMENT II.	Narrow ration, .	14.63	.563	3.52	5.19	9.44	1:1.82	13.33	.468	2.92	4.95	8.38	1:1.69	13.33	.579	3.62	4.89	8.44	1:1.72
		14.62	.559	3.49	5.17	9.45	1:1.82	13.11	.522	3.26	4.39	8.72	1:1.98	14.36	.578	3.61	4.82	9.54	1:1.98
		14.68	.572	3.57	5.24	9.44	1:1.80	13.40	.511	3.19	4.62	8.78	1:1.90	14.34	.588	3.67	4.75	9.59	1:2.02
	Average, . .	14.64	.565	3.53	5.20	9.44	1:1.81	13.28	.500	3.12	4.65	8.63	1:1.86	14.01	.582	3.63	4.82	9.19	1:1.91
	Wide ration, .	14.92	.546	3.41	5.42	9.50	1:1.75	12.93	.455	2.84	4.37	8.56	1:1.96	14.67	.559	3.49	5.34	9.33	1:1.75
		14.95	.547	3.42	5.44	9.51	1:1.75	12.70	.472	2.95	4.21	8.49	1:2.02	14.96	.579	3.62	5.59	9.37	1:1.68
		14.80	.552	3.45	5.19	9.61	1:1.85	13.21	.468	2.92	4.62	8.59	1:1.86	14.81	.595	3.72	5.33	9.48	1:1.78
	Average, . .	14.89	.548	3.43	5.35	9.54	1:1.78	12.95	.465	2.90	4.40	8.55	1:1.95	14.81	.584	3.61	5.42	9.39	1:1.74

In judging the above results, it must not be forgotten that the entire lot of cows was not fed *at the same time* on either the wide or the narrow ration. For example, in Experiment I. cows I., IV. and VI. were first fed the narrow ration; while cows II., III. and V. were having at the same time the wide ration. It would be expected that cows I., IV. and VI. would naturally show slightly higher percentages on the wide ration, *because it was fed later;* and for a like reason cows II., III. and V. would show higher percentages on the narrow ration. In case of Cow V., on the wide ration, it has already been explained that the first two composite samples of milk show low solids, and less than 3 per cent. of fat. In the third sample both the solids and fat very noticeably increased. It is evident that this sudden change was not caused by feed; first, because the animal was in excellent flesh at the beginning of the experiment; and, second, because the change was a permanent one. The cow had been calved but a few weeks, and for some reason had not come to her average quality of milk. It was therefore considered advisable, in the wide ration, to omit in the average the first two analyses. With this exception, the first experiment shows very little variation in the quality of the milk. In the second experiment, cows I., II. and VI. were first fed the narrow ration, and cows III., IV. and V. first received the wide ration. All but Cow II. being somewhat advanced in the period of lactation, it is natural that at least cows I. and VI. should show slightly higher percentages with the wide ration, and cows III., IV. and V. with the narrow ration. This natural tendency is noticed in cows I., II., IV., V. and VI. One can therefore draw more reliable conclusions when the results from the six cows are averaged, thus eliminating as much as possible the error caused by natural shrinkage.

TABLE VI. — *Average Results from 6 Cows.*

Experiment I.

	Average Weight of Animals (Pounds).	Daily Digestible Nutrients consumed.					Composition of Milk.			
		Protein (Pounds).	Fat (Pounds).	Carbohydrates (Pounds).	Total Nutrients (Pounds).	Nutritive Ratio.	Total Solids (Per Cent.).	Nitrogenous Matter (Per Cent.)	Fat (Per Cent.).	Solids not Fat (Per Cent.).
Narrow ration, . .	941	3.07	.59	10.23	14.06	1:3.86	13.66	-	4.51	9.15
Wide ration, . . .	938	1.46	.52	12.45	14.43	1:9.43	13.56	-	4.47	9.09
Percentage increase narrow over wide.	-	-	-	-	-	-	+.73	-	+.89	+.66

Experiment II.

	Average Weight of Animals (Pounds).	Protein (Pounds).	Fat (Pounds).	Carbohydrates (Pounds).	Total Nutrients (Pounds).	Nutritive Ratio.	Total Solids (Per Cent.).	Nitrogenous Matter (Per Cent.)	Fat (Per Cent.).	Solids not Fat (Per Cent.).
Narrow ration, . .	899	2.85	.65	9.96	13.46	1:4.04	13.83	3.29	4.83	9.00
Wide ration, . . .	890	1.45	.54	11.44	13.42	1:8.85	14.12	3.24	5.02	9.10
Percentage increase narrow over wide.	-	-	-	-	-	-	−2.10	+1.52	−3.93	−1.11

The average weights of the animals during both periods of each experiment are practically identical. In the first experiment the milk appears to have suffered no change in composition. In the second experiment the wide ration seems to have slightly increased the solids and fat and diminished the nitrogenous matter. This is more strikingly brought out in Table VII.

TABLE VII. — *Showing Percentages on Basis of 14 Per Cent. Solids.*

	Experiment I.		Experiment II.		
	Fat (Per Cent.).	Solids not Fat (Per Cent.).	Nitrogenous Matter (Per Cent)	Fat (Per Cent.).	Solids not Fat (Per Cent.).
Narrow ration, ...	4.62	9.38	3.33	4.88	9.11
Wide ration, ...	4.61	9.39	3.21	4.97	9.02
Percentage increase narrow over wide,	±	±	+3.60	−1.84	+ .99

In Table VII. it will be noticed that the wide ration, containing 1.45 pounds of digestible protein, .54 pound of digestible fat and 11.44 pounds of digestible carbohydrates, seemed to have produced a slight but noticeable increase in the percentage of fat; and the narrow ration, containing 2.85 pounds of digestible protein, .65 pound of digestible fat and 9.96 pounds of digestible carbohydrates, a slight increase in the total nitrogenous matter.

Recognizing the many serious difficulties in the way of securing results that will show *only* the influence of feed or feed constituents in the composition of milk, the writer would of course draw no positive conclusions, but simply present the figures as the results of two carefully conducted experiments along this line of investigation.

Complete Data of Experiments.

Table VIII. — *Total Feeds consumed, and Total Yield and Cost of Milk and Butter.*

Experiment I. Narrow Ration.

COW.	Feeds consumed.					Milk and Butter produced.				Cost of Milk and Butter.			
						Milk.		Butter.					
	Hay (Pounds).	Sugar Beets (Pounds).	Wheat Bran (Pounds).	Chicago Gluten Meal (Pounds).	Corn Meal (Pounds).	Total (Pounds).	Average Daily Yield (Pounds).	Total Butter Fat (Pounds).	Equal to Butter (Pounds).	Total Cost of Feeds consumed.	Cost of Feed per 100 Pounds of Milk (Cents).	Cost per Pound Butter Fat (Cents).	Cost per Pound Butter (Cents).
Ada,	312	312	78	130	-	655.2	25.2	27.13	31.65	$5 28	80.6	19.46	16.68
Una,	364	312	78	156	-	592.4	22.8	26.36	30.76	5 96	100.6	22.61	19.37
Bessie,	390	312	78	156	-	813.6	31.3	35.07	40.91	6 16	75.7	17.56	15.05
Beauty,	468	312	78	156	-	631.2	24.3	32.13	37.48	6 74	106.8	20.97	17.99
Red,	416	312	78	156	-	777.6	29.9	31.34	36.56	6 35	81.6	20.26	17.37
Spot,	416	312	78	156	-	771.5	29.7	38.87	45.35	6 35	82.4	16.32	14.00
Wide Ration.													
Ada,	338	312	78	-	130	559.3	21.5	23.10	26.95	$5 09	90.9	22.03	18.88
Una,	390	312	78	-	156	559.4	21.5	24.78	28.91	5 70	101.9	23.00	19.71
Bessie,	416	312	78	-	156	719.2	27.7	30.28	35.33	5 89	81.9	19.45	16.67
Beauty,	494	312	78	-	156	522.5	20.1	26.48	30.89	6 48	124.1	24.50	21.00
Red,	442	312	78	-	156	761.7	29.3	25.13	29.30	6 09	80.0	24.26	20.80
Spot,	442	312	78	-	156	573.9	22.1	28.41	33.14	6 09	106.1	21.44	18.38

TABLE IX. — *Total Feeds consumed, and Total Yield and Cost of Milk and Butter.*

Experiment II. Narrow Ration.

COW.	Feeds consumed.					Milk and Butter produced.				Cost of Milk and Butter.			
						Milk.		Butter.					
	Hay (Pounds).	Millet and Soy-bean Ensilage (Pounds).	Wheat Bran (Pounds).	Chicago Gluten Meal (Pounds).	Old-process Linseed Meal (Pounds).	Total (Pounds).	Average Daily Yield (Pounds).	Total Butter Fat (Pounds).	Equal to Butter (Pounds).	Total Cost of Feeds consumed.	Cost of Feed per 100 Pounds of Milk (Cents).	Cost per Pound Butter Fat (Cents).	Cost per Pound Butter (Cents).
Ada,	189	420	42	63	31.5	474.9	22.6	20.47	23.88	$3 68	76.4	17.70	15.90
Guernsey,	210	630	63	63	42	617.4	29.4	32.91	38.39	4 48	72.6	13.62	11.66
Bessie,	210	630	63	63	42	593.2	28.2	27.58	32.20	4 48	75.5	16.23	13.91
Beauty,	220	630	63	63	42	459.4	21.9	23.89	27.87	4 56	99.3	19.10	16.34
Red,	220	630	63	63	42	556.8	26.5	25.90	30.21	4 56	81.9	17.60	15.10
Spot,	220	630	63	63	42	559.0	26.6	26.94	31.43	4 56	81.5	16.93	14.52

Wide Ration.

COW.	Hay (Pounds).	Millet and Soy-bean Ensilage (Pounds).	Wheat Bran (Pounds).	*Corn Meal.*	Old-process Linseed Meal (Pounds).	Total (Pounds).	Average Daily Yield (Pounds).	Total Butter Fat (Pounds).	Equal to Butter (Pounds).	Total Cost of Feeds consumed.	Cost of Feed per 100 Pounds of Milk (Cents).	Cost per Pound Butter Fat (Cents).	Cost per Pound Butter (Cents).
Ada,	189	420	31.5	105	-	402.1	19.5	17.70	20.65	$3 34	83.1	18.87	16.21
Guernsey,	210	630	42	126	-	512.7	24.4	28.15	32.84	4 17	81.3	14.84	12.71
Bessie,	210	630	42	126	-	508.1	24.2	25.81	30.11	4 17	82.1	16.16	13.85
Beauty,	220	630	42	126	-	439.7	20.9	23.53	27.45	4 25	96.6	18.90	15.51
Red,	220	630	42	126	-	553.6	26.4	24.37	28.42	4 25	76.7	17.41	15.00
Spot,	220	630	42	126	-	461.3	22.0	25.00	29.17	4 25	92.2	17.00	14.55

TABLE X. — *Daily Feeds consumed.*

Experiment I. Narrow Ration.

COW.	Feeds consumed (Pounds) per Day. Hay.	Sugar Beets.	Wheat Bran.	Chicago Gluten Meal.	Corn Meal.	Dry Matter consumed per Day (Pounds).	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Nutrients (Pounds).	Nutritive Ratio of Ration.	Weight at Beginning and End of Experiment (Pounds).	Average Weight (Pounds).
Ada, ...	12	12	3	5	-	19.24	2.66	.51	8.85	12.02	1:3.80	788-810	794
Una, ...	14	12	3	6	-	21.85	3.08	.58	10.00	13.66	1:3.72	870-900	905
Bessie, ...	15	12	3	6	-	22.75	3.12	.59	10.39	14.10	1:3.80	869-874	860
Beauty, ...	18	12	3	6	-	25.41	3.24	.63	11.59	15.46	1:4.03	1,037-1,055	1,038
Red, ...	16	12	3	6	-	23.59	3.16	.61	10.77	14.54	1:3.90	1,040-1,058	1,061
Spot, ...	16	12	3	6	-	23.65	3.16	.61	10.79	14.56	1:3.90	1,000-1,008	987

Wide Ration.

COW.	Hay.	Sugar Beets.	Wheat Bran.	Chicago Gluten Meal.	Corn Meal.	Dry Matter consumed per Day (Pounds).	Digestible Protein (Pounds).	Digestible Fat (Pounds).	Digestible Carbohydrates (Pounds).	Total Digestible Nutrients (Pounds).	Nutritive Ratio of Ration.	Weight at Beginning and End of Experiment (Pounds).	Average Weight (Pounds).
Ada, ...	13	12	3	-	5	20.13	1.29	.45	10.68	12.42	1:9.16	805-801	807
Una, ...	14.50	12	3	-	6	22.30	1.40	.51	11.91	13.82	1:9.40	394-884	888
Bessie, ...	16	12	3	-	6	23.67	1.46	.53	12.53	14.52	1:9.50	890-862	867
Beauty, ...	19	12	3	-	6	26.22	1.57	.56	13.57	15.70	1:9.54	1,045-1,033	1,044
Red, ...	17	12	3	-	6	24.55	1.50	.54	12.93	14.97	1:9.52	1,020-1,038	1,025
Spot, ...	17	12	3	-	6	24.48	1.50	.54	12.88	14.92	1:9.49	1,010-982	995

TABLE XI. — *Daily Feeds consumed.*

Experiment II. Narrow Ration.

COW.	Feeds consumed Daily (Pounds). Hay.	Millet and Soy-bean Ensilage.	Wheat Bran.	Chicago Gluten Meal.	Linseed Meal.	Corn Meal.	Dry Matter consumed Daily (Pounds).	Digestible Matter consumed Daily (Pounds). Protein.	Fat.	Carbohydrates.	Total Nutrients.	Nutritive Ratio of Ration.	Weight at Beginning and End of Experiment (Pounds).	Average Weight (Pounds).
Ada,	9	20	2	3	1.5	-	17.43	2.41	.52	8.05	10.98	1:3.9	770-762	763
Guernsey,	10	30	3	3	2	-	21.49	2.89	.66	9.88	13.43	1:4.0	862-860	861
Bessie,	10	30	3	3	2	-	22.15	2.93	.67	10.21	13.81	1:4.0	835-822	828
Beauty,	11	30	3	3	2	-	23.05	2.98	.68	10.65	14.31	1: .1	995-975	981
Red,	11	30	3	3	2	-	23.05	2.98	.68	10.65	14.31	1:4.1	1,022-1,022	1,017
Spot,	11	30	3	3	2	-	22.37	2.98	.67	10.32	13.97	1:4.1	948-940	943

Wide Ration.

COW.	Hay.	Millet and Soy-bean Ensilage.	Wheat Bran.	Chicago Gluten Meal.	Linseed Meal.	Corn Meal.	Dry Matter consumed Daily (Pounds).	Protein.	Fat.	Carbohydrates.	Total Nutrients.	Nutritive Ratio of Ration.	Weight at Beginning and End of Experiment (Pounds).	Average Weight (Pounds).
Ada,	9	20	1.5	-	-	5	17.63	1.20	.44	9.58	11.22	1:8.90	775-770	772
Guernsey,	10	30	2	-	-	6	21.80	1.50	.56	11.74	13.80	1:8.76	850-835	838
Bessie,	10	30	2	-	-	6	21.12	1.44	.55	11.41	13.40	1:8.88	814-835	824
Beauty,	11	30	2	-	-	6	22.00	1.49	.56	11.85	13.90	1:8.89	970-960	958
Red,	11	30	2	-	-	6	22.00	1.49	.56	11.85	13.90	1:8.89	1,011-1,007	1,004
Spot,	11	30	2	-	-	6	22.70	1.55	.57	12.18	14.30	1:8.78	940-945	942

TABLE XII. — *Showing Total Amount of Dry and Digestible Matter consumed, and Total Milk Products produced.*

Experiment I.

CHARACTER OF RATION.	Dry Matter consumed (Pounds).	Digestible Matter consumed (Pounds).	Milk produced (Pounds).	Milk Solids produced (Pounds).	Milk Fat produced (Pounds).
Narrow, ...	3,549.0	2,193.4	4,241.5	579.4	191.3
Wide, ...	3,675.4	2,251.1	3,695.5	501.1	165.2

Experiment II.

CHARACTER OF RATION.	Dry Matter consumed (Pounds).	Digestible Matter consumed (Pounds).	Milk produced (Pounds).	Milk Solids produced (Pounds).	Milk Fat produced (Pounds).
Narrow, ...	2,721.6	1,696.0	3,261.0	451.0	157.5
Wide, ...	2,671.2	1,691.0	2,877.0	406.2	144.4

TABLE XIII. — *Showing for Every 100 Pounds of Dry and Digestible Matter consumed, Amounts of Milk, Milk Solids and Milk Fat produced.*

Narrow Ration.

ONE HUNDRED POUNDS.	EXPERIMENT I.			EXPERIMENT II.		
	Milk (Pounds).	Milk Solids (Pounds).	Fat (Pounds).	Milk (Pounds).	Milk Solids (Pounds).	Fat (Pounds).
Dry matter produced, ...	119.51	16.32	5.39	119.8	16.6	5.8
Digestible matter produced, ...	193.41	26.42	8.72	192.3	26.6	9.3

Wide Ration.

ONE HUNDRED POUNDS.	EXPERIMENT I.			EXPERIMENT II.		
	Milk (Pounds).	Milk Solids (Pounds).	Fat (Pounds).	Milk (Pounds).	Milk Solids (Pounds).	Fat (Pounds).
Dry matter produced, ...	100.28	13.74	4.48	107.7	15.4	5.40
Digestible matter produced, ...	164.16	22.28	7.34	170.1	24.0	8.54

TABLE XIV. — *Pounds of Digestible Matter required to produce 100 Pounds of Milk, a Pound of Milk Solids and a Pound of Butter.*

Narrow Ration.

POUNDS REQUIRED OF —	Experiment I. To produce — 100 Pounds Milk.	Experiment I. To produce — One Pound Milk Solids.	Experiment I. To produce — One Pound Butter.	Experiment II. To produce — 100 Pounds Milk.	Experiment II. To produce — One Pound Milk Solids.	Experiment II. To produce — One Pound Butter.
Digestible matter,	51.7	3.78	9.83	52.0	3.76	9.2

Wide Ration.

Digestible matter,	60.9	4.49	11.68	58.8	4.16	10.04

TABLE XV. — *Composition of Feeds (Dry Matter).*

Experiment I.

	Hay (Per Cent.).	Digestion Coefficients.	Sugar Beets (Per Cent.).	Digestion Coefficients.	Millet and Soy-bean Ensilage (Per Cent.).	Digestion Coefficients.	Wheat Bran (Per Cent.).	Digestion Coefficients.	Chicago Gluten Meal (Per Cent.).	Digestion Coefficients.	Old-process Lin-seed Meal (Per Cent.).	Digestion Coefficients.	Corn Meal (Per Cent.).	Digestion Coefficients.	Waste (Cow II., Wide Ration).*
Ash,	6.02	-	9.16	-	-	-	5.77	-	1.16	-	-	-	1.43	-	5.10
Fiber,	33.13	47	8.58	-	-	-	11.63	22	3.12	-	-	-	2.06	-	43.66
Fat,	2.65	53	.63	-	-	-	5.64	71	5.96	93	-	-	4.46	92	1.58
Protein,	9.73	45	8.65	62	-	-	19.20	78	42.73	89	-	-	11.36	60	6.21
Extract matter,	48.47	60	72.98	98	-	-	57.76	68	47.03	93	-	-	80.69	93	43.45

Experiment II.

	Hay (Per Cent.).	Digestion Coefficients.	Sugar Beets (Per Cent.).	Digestion Coefficients.	Millet and Soy-bean Ensilage (Per Cent.).	Digestion Coefficients.	Wheat Bran (Per Cent.).	Digestion Coefficients.	Chicago Gluten Meal (Per Cent.).	Digestion Coefficients.	Old-process Lin-seed Meal (Per Cent.).	Digestion Coefficients.	Corn Meal (Per Cent.).	Digestion Coefficients.	Waste (Cow II., Wide Ration).*
Ash,	5.32	-	-	-	10.55	-	6.41	-	.90	-	4.94	-	1.27	-	-
Fiber,	32.27	60	-	-	36.07	69	11.03	22	3.63	-	7.26	50	2.44	-	-
Fat,	2.72	49	-	-	4.25	72	5.62	71	6.06	93	7.05	89	4.12	92	-
Protein,	9.21	59	-	-	12.01	57	18.87	78	39.75	89	41.99	89	11.36	60	-
Extract matter,	50.48	59	-	-	37.12	59	58.07	68	49.66	93	38.76	78	80.80	93	-

* Amounting to 14.75 pounds and containing 85 per cent. of dry matter.

TABLE XVI. — *Dry Matter Determinations.*

Experiment I.

	Hay (Per Cent.).	Sugar Beets (Per Cent.).	Millet and Soy-bean Ensilage (Per Cent.).	Wheat Bran (Per Cent.).	Chicago Gluten Meal (Per Cent.).	Old-process Linseed Meal (Per Cent.).	Corn Meal (Per Cent.).
October 24 to November 19, .	87.5	13.00	–	88.3	91.0	–	87.7
November 28 to December 24, .	87.0	14.70	–	88.6	91.0	–	87.7

Experiment II.

	Hay (Per Cent.).	Sugar Beets (Per Cent.).	Millet and Soy-bean Ensilage (Per Cent.).	Wheat Bran (Per Cent.).	Chicago Gluten Meal (Per Cent.).	Old-process Linseed Meal (Per Cent.).	Corn Meal (Per Cent.).
January 27 to February 17, .	88 0	–	18.4	88.0	91.0	90.0	84.5
February 29 to March 21, . .	91.0	–	19.7	88.0	91.0	90.0	84.5

Market Cost of Feed Stuffs per Ton.

	Experiment I.	Experiment II.
Hay, ...	$15 00	$15 00
Sugar beets, ...	5 00	–
Millet and soy-bean ensilage, ...	–	4 00
Wheat bran, ...	17 00	16 00
Chicago gluten meal, ...	23 00	22 00
Linseed meal, ...	–	22 00
Corn meal, ...	17 00	16 00

FEEDING EXPERIMENTS WITH PIGS.

(*b*) Rice Meal *v.* Corn Meal.

Experiment I. — *Nov. 12, 1895, to Feb. 11, 1896.*

Results.

Three pigs fed rice meal and skim-milk each showed an average weight of 67 pounds at the beginning of the experiment and 195.2 pounds at the end of the experiment; the three fed corn meal and skim-milk each showed an average weight of 65 pounds at the beginning and 193.5 pounds at the end of the experiment.

The rice meal lot consumed during the experiment 3,519 pounds of skim-milk (1,614 quarts), together with 867 pounds of rice meal, and gained 385 pounds of live weight, equal to 298 pounds of dressed weight; the corn meal lot consumed like quantities of milk and corn meal, and gained 385 pounds of live weight, equal to 309 pounds of dressed weight.

The rice meal lot consumed 1,118.64 pounds of dry matter and the corn meal lot 1,105.65 pounds of dry matter.

The rice meal lot required 2.91 pounds of dry matter to produce 1 pound of live weight and 3.77 pounds to produce 1 pound of dressed weight; the corn meal lot required 2.91 pounds of dry matter to produce 1 pound of live weight and 3.59 pounds to produce 1 pound of dressed weight.

The average daily gain in live weight of each pig in both the rice and corn meal lots was 1.41 pounds.

The three pigs fed rice meal showed an average shrinkage of 22.64 per cent. in dressing; the corn meal fed pigs shrank 20 per cent.

The above results indicate that a good quality of rice meal has a feeding value equal to a similar quality of corn meal.

With grain at $18 per ton and dressed pork at 5 cents per pound, skim-milk returned ½ of a cent per quart, or 23 cents

per 100 pounds; with the same price for grain and dressed pork at 6 cents per pound, skim-milk would return 31.5 cents per 100 pounds.

With grain at $18 per ton and skim-milk at 15 cents per 100 pounds, live weight would cost 2.88 cents per pound and dressed weight 3.66 cents. If skim-milk were reckoned at 25 cents per 100 pounds, live weight would cost 4 cents per pound and dressed weight 5 cents per pound.

Details of the Experiment.

The object of the experiment was to compare the nutritive effect of rice meal with corn meal when fed in connection with skim-milk. Six pigs, grade Chester White, all out of the same litter, were selected. They were received October 15, when six weeks old, and kept for a month before beginning the experiment. Before starting the experiment each pig was placed in a separate pen, of about 100 feet area. The pens were separated by heavy galvanized wire, thus securing good ventilation, and allowing at the same time the animals to see each other. While they had no outdoor run, the pens were large, the room airy and well lighted, and the constant good health of the animals indicated no disturbing influences. Only in very severe weather did the temperature in the building fall a little below freezing.

Feeding. — The animals were fed three times daily, the slightly warmed milk being measured, and the grain ration for the twenty-four hours accurately weighed. The pigs were each given from 5 to 6 quarts of milk daily. At the beginning of the experiment 4 ounces of grain were given with each quart of milk; and the amount increased from time to time, to suit the appetites of the animals. The feed was consumed during the entire time, without a single refusal.

Feeds. — The skim-milk was tested occasionally, and 9.75 per cent. of solids were used in calculating the amount of dry matter it contained. Rice meal is fed and highly prized in Europe. It is occasionally found in our markets, but the present low price of corn meal excludes it. In preparing rice for human consumption, various mechanical processes are employed. After the hull is removed, the rice is

brought into mortars holding from 4 to 6 bushels each and pounded, to remove the yellow, gluey covering of the grain and give it the creamy color so much desired. This pounding really removes the chaff and some of the flour, and leaves the grain but little broken. The rice is then polished to give it a pearly lustre, which is effected by friction of the grains of rice against tanned moose hide. That portion rubbed off is termed rice polish. The chaff and flour above referred to, and in some cases the polish also, are mixed and sold as rice meal for cattle feeding.

Composition.

[Figures equal percentages or pounds per 100.]

	Rice Meal.	Corn Meal.
Water,	10.50	12.00
Ash,	7.67	1.42
Fiber,	5.03	1.84
Fat,	12.10	3.34
Protein,	12.95	9.68
Extract matter,	51.75	71.72

The above feeds have the same type of composition, being comparatively low in protein and high in carbohydrates. They both may be termed heat-producing and fattening feeds. The rice meal contains more fat and less extract or starchy matter than the corn meal.

Data of the Experiment (Nov. 12, 1895, to Feb. 12, 1896).

LOT I — *Rice Meal*

NUMBER OF PIG.	Skim-milk consumed.			Grain consumed.			Weight at Beginning of Experiment (Pounds).	Weight at End of Experiment (Pounds).	Gain in Live Weight (Pounds).	Daily Gain in Live Weight (Pounds).	Loss of Weight in Dressing (Per Cent.).	Computed Dressed Weight at Beginning of Experiment (Pounds).	Dressed Weight at End of Experiment (Pounds).	Gain in Dressed Weight (Pounds).	Dry Substance used to produce One Pound Live Weight (Pounds).	Dry Substance used to produce One Pound Dressed Weight (Pounds).
	Quarts.	Pounds.	Dry Matter (Pounds).	Corn Meal (Pounds).	Rice Meal (Pounds).	Dry Matter (Pounds).										
I, ...	538	1,172.8	114.35	-	288.87	258.5	67.25	187.00	119.75	1.32	22.86	51.88	144.25	92.37	3.11	4.04
II, ...	538	1,172.8	114.35	-	288.87	258.5	67.25	199.25	132.00	1.45	23.46	51.47	152.50	101.03	2.82	3.69
III., ...	538	1,172.8	114.35	-	288.87	258.5	67.00	200.25	132.25	1.46	21.59	52.53	157.00	104.47	2.80	3.57
Total, . . .	1,614	3,518.5	343.05	-	866.60	775.6	201.50	586.50	385.00	4.23	-	155.88	453.75	297.81	-	-
Average per pig, .	538	1,172.8	114.35	-	288.87	258.5	67.00	195.20	128.30	1.41	22.64	51.96	151.28	99.37	2.91	3.77

LOT II. — *Corn Meal.*

NUMBER OF PIG.	Quarts.	Pounds.	Dry Matter (Pounds).	Corn Meal (Pounds).	Rice Meal (Pounds).	Dry Matter (Pounds).	Weight at Beginning of Experiment (Pounds).	Weight at End of Experiment (Pounds).	Gain in Live Weight (Pounds).	Daily Gain in Live Weight (Pounds).	Loss of Weight in Dressing (Per Cent.).	Computed Dressed Weight at Beginning of Experiment (Pounds).	Dressed Weight at End of Experiment (Pounds).	Gain in Dressed Weight (Pounds).	Dry Substance used to produce One Pound Live Weight (Pounds).	Dry Substance used to produce One Pound Dressed Weight (Pounds).
I., ...	538	1,172.8	114.35	288.87	-	254.20	67.00	192.50	125.50	1.38	19.74	53.77	154.50	100.73	2.94	3.66
II., ...	538	1,172.8	114.35	288.87	-	254.20	58.75	184.50	125.75	1.41	20.73	46.57	146.25	99.68	2.93	3.70
III., ...	538	1,172.8	114.35	288.87	-	254.20	69.25	203.50	134.25	1.48	19.41	55.81	164.00	108.19	2.74	3.41
Total, . . .	1,614	3,518.5	343.05	866.60	-	762.60	195.00	580.50	385.50	4.27	-	156.15	464.75	308.60	-	-
Average per pig, .	538	1,172.8	114.35	288.87	-	254.20	65.00	193.50	128.50	1.42	19.96	52.05	154.92	102.90	2.90	3.59

Additional Data.

In order to throw light on the price returned for skim-milk and the cost of feed required to produce a pound of live and dressed weight, the following additional data is presented, and the amount of feed consumed is reckoned from October 15, when the pigs were received, to February 12, when they were slaughtered. The results below are based on the entire lot of six pigs.

	Quarts.	Pounds.
Total milk consumed by six pigs,	4,092	8,921
Total grain consumed by six pigs,	-	1,920
Live weight actually gained,	-	968
Dressed weight actually gained,	-	762

PRICE RETURNED FOR SKIM-MILK.	WHEN CORN MEAL SELLS AT $18 PER TON AND DRESSED PORK AT —				WHEN CORN MEAL SELLS AT $24 PER TON AND DRESSED PORK AT —			
	Five Cents.	Six Cents.	Seven Cents.	Eight Cents.	Five Cents.	Six Cents.	Seven Cents.	Eight Cents.
Per quart (fraction of cent),	.50	.69	.87	1.06	.36	.54	.73	.91
Per 100 pounds (cents),	23.00	31.50	40.00	48.50	16.00	25.00	33.00	42.00

The pigs were six weeks old when they were received, and weighed about 33 pounds each. When slaughtered they averaged 194.5 pounds each. The pigs made a rapid growth, and the results are fully as favorable as could be hoped for.

Cost of Feed per Pound of Growth produced (Cents).

	Live Weight.	Dressed Weight.
When corn meal costs $18 per ton and milk ¼ cent per quart,	2.88	3.66
When corn meal costs $18 per ton and milk ½ cent per quart,	4.00	5.00
When corn meal costs $24 per ton and milk ¼ cent per quart,	3.48	4.43
When corn meal costs $24 per ton and milk ½ cent per quart,	4.55	5.80

(c) Oat Feed v. Corn Meal for Pigs.

Experiment II. — *March 29 to June 30, 1896.*

Results.

Four pigs fed oat feed and skim-milk each showed an average weight of 42.56 pounds at the beginning and 136.75 pounds at the end of the experiment; the two fed corn meal and milk showed an average weight of 45.25 pounds at the beginning and 157.70 pounds at the end of the experiment.

The oat feed lot consumed during the experiment 5,389 pounds of skim-milk (2,474 quarts), together with 869 pounds of oat feed, and gained 376.75 pounds of live weight, an average gain of 94.19 pounds each; the corn meal lot consumed 2,694.5 pounds of milk (1,236 quarts), together with 435 pounds of corn meal, and gained 225.25 pounds, or an average gain of 112.62 pounds.

The oat feed lot consumed 1,305.96 pounds of dry matter and required 3.47 pounds of dry matter to produce a pound of live weight; the corn meal lot consumed 645.1 pounds of dry matter and required 2.86 pounds of dry matter to produce a pound of live weight.

The oat feed lot showed an average daily gain of 1.03 pounds in live weight, and the corn meal lot a daily gain of 1.22 pounds in live weight.

The present experiment shows that only 83.6 per cent. as much pork was produced with oat feed as with an equal weight of corn meal, or 100 pounds of corn meal were equal to 120 pounds of oat feed.

With corn meal at $18 per ton, oat feed at $16 per ton and dressed pork at 5 cents per pound, skim-milk returned $\frac{1}{3}$ of a cent per quart, or 15.6 cents per 100 pounds in case of the entire lot of six pigs.

With the same price for grain and skim-milk reckoned at $\frac{1}{4}$ cent per quart, live weight would cost 3.34 cents and dressed weight 4.3 cents per pound. Further details concerning prices will be found in the description of the experiment.

Details of Experiment II.

The object of this experiment was to compare the nutritive effect of corn meal with oat feed. Six grade Chester White pigs, all from the same litter, were used. The pigs were kept in the same pens and handled in the same way as described in the previous experiment. They had been in the pens over a month before the experiment began.

Feeding.— The pigs were each fed at the beginning 5 quarts of milk together with 3 ounces of meal to each quart of milk, and increased in this proportion till 8 quarts of milk were fed; the grains were then still further increased from time to time to satisfy the appetites of the animals.

Feeds.— The skim-milk and corn meal were of the same average quality as reported in the previous experiment. Oat feed is the refuse from factories engaged in the preparation of oat meal for human consumption. It consists of the poor oats, oat hulls and some of the bran and starch which are removed in the process of manufacture. It is, as the corn meal, a heat-producing rather than a flesh-forming feed. Oat feed varies very much in composition, and consequently in feeding value. The sample used may be considered an average one.

Composition.

[Figures equal percentages or pounds per 100.]

	Oat Feed.	Corn Meal.
Water,	10.00	12.00
Ash,	5.00	1.42
Fiber,	14.75	1.84
Fat,	3.72	3.34
Protein,	12.19	9.68
Extract matter,	54.34	71.72

The presence of the high percentage of fiber in the oat feed is indicative of a considerable amount of hulls.

Data of the Experiment (March 29 to June 30, 1896).

Lot I. — *Oat Feed.*

NUMBER OF PIG.	Skim-milk consumed.			Grains consumed.			Live Weight at Beginning of Experiment (Pounds).	Live Weight at End of Experiment (Pounds).	Total Gain in Live Weight (Pounds).	Daily Gain in Live Weight (Pounds).	Dry Matter needed to produce a Pound of Live Weight (Pounds).
	Quarts.	Pounds.	Dry Matter (Pounds).	Oat Feed (Pounds).	Corn Meal (Pounds).	Dry Matter (Pounds).					
I.,	618	1,347.24	131.36	217.3	-	195.13	46.75	140.75	94.00	1.02	3.47
II.,	618	1,347.24	131.36	217.3	-	195.13	35.75	121.75	86.00	.94	3.89
III.,	618	1,347.24	131.36	217.3	-	195.13	43.50	143.75	100.25	1.09	3.26
IV.,	618	1,347.24	131.36	217.3	-	195.13	44.25	140.75	96.50	1.05	3.38
Total,	2,472	5,388.96	525.44	869.2	-	780.52	170.25	547.00	376.75	-	-
Average per pig,	618	1,347.24	131.36	217.3	-	195.13	42.56	136.75	94.19	1.03	3.50

Lot II. — *Corn Meal.*

NUMBER OF PIG.	Quarts.	Pounds.	Dry Matter (Pounds).	Oat Feed (Pounds).	Corn Meal (Pounds).	Dry Matter (Pounds).	Live Weight at Beginning of Experiment (Pounds).	Live Weight at End of Experiment (Pounds).	Total Gain in Live Weight (Pounds).	Daily Gain in Live Weight (Pounds).	Dry Matter needed to produce a Pound of Live Weight (Pounds).
V.,	618	1,347.24	131.36	-	217.3	191.20	43.25	154.57	111.50	1.21	2.89
VII.,	618	1,347.24	131.36	-	217.3	191.20	47.25	160.75	113.75	1.24	2.84
Total,	1,236	2,694.48	262.72	-	434.6	382.40	90.50	315.50	225.25	-	-
Average per pig,	618	1,347.24	131.36	-	217.3	191.20	45.25	157.70	112.62	1.22	2.86

Additional Data.

In order to show the price returned for skim-milk and the cost of feed required to produce a pound of live and dressed weight, the additional data is presented for the six pigs: —

	Quarts.	Pounds.
Total milk consumed by six pigs, ...	3,708	8,083.5
Total oat feed consumed by six pigs, ...	–	869.0
Total corn meal consumed by six pigs, ...	–	435.0
Live weight actually gained, ...	–	602.0
Dressed weight calculated, ...	–	470.0

PRICE RETURNED FOR SKIM-MILK.	WITH OAT FEED AT $16 PER TON, CORN MEAL AT $18 PER TON AND DRESSED PORK AT —				WITH OAT FEED AT $21 PER TON, CORN MEAL AT $24 PER TON AND DRESSED PORK AT —			
	Five Cents.	Six Cents.	Seven Cents.	Eight Cents.	Five Cents.	Six Cents.	Seven Cents.	Eight Cents.
Per quart (fraction of cent), . . .	.34	.47	.60	.72	.25	.37	.50	.62
Per 100 pounds (cents),	15.60	21.40	27.00	33.00	11.00	17.00	23.00	29.00

The pigs did not grow as rapidly as in the first experiment, and consequently the returns are below those obtained with the previous lot. The animals seemed inferior, and unable to turn the feed into rapid growth. The above figures are more nearly what might be expected by the average farmer.

Cost of Feed per Pound of Growth produced (Cents).

	Live Weight.	Dressed Weight.
With grain prices at $16 and $18 and milk at ¼ cent per quart, .	3.34	4.30
With grain prices at $16 and $18 and milk at ½ cent per quart, .	4.88	6.25
With grain prices at $21 and $24 and milk at ¼ cent per quart, .	3.90	5.00
With grain prices at $21 and $24 and milk at ½ cent per quart, .	5.46	7.00

(d) Digestion Experiments with Sheep.

We have continued our digestion studies of the various cattle feeds during the past year. Some of the work undertaken is as yet incomplete, and experiments are still in progress. Below is presented the digestion coefficients obtained with several feed stuffs. The entire data will be presented at another time. By digestion coefficients is meant the percentage of the several groups of constituents composing feed stuffs that the animal is capable of digesting. Thus, if wheat bran contains 16 per cent. of protein, or 16 pounds in 100, and the coefficient of the protein digestibility is 78, this means that the animal can digest 78 per cent. of the 16 pounds, or 12.48 pounds.

Digestion Coefficients obtained.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Fiber (Per Cent.).	Fat (Per Cent.).	Protein (Per Cent.).	Extract Matter (Per Cent.).
Rice meal,	1	2	74	(?)	91	62	92
Pope gluten feed,	1	2	87	77	81	86	90
Pope gluten meal,	1	2	93	(?)	98	84	88
Millet and soy-bean ensilage,	1	4	59	69	72	57	59
Corn and soy-bean ensilage,	1	3	69	65	82	65	75
Hay (mostly timothy),	1	2	55	57	57	54	55

Compilation of Analyses of Fodder Articles and Dairy Products,

made at

AMHERST, MASS.

1868-1897.

Prepared by E. B. Holland.

A. Fodder Articles.

B. Fertilizing Ingredients in Fodders.

C. Dairy Products.

A. *Composition and Digestibility of Cattle Feeds.*

[Figures equal percentages or pounds in 100.]

NAME.	Analyses.	Composition.										Digestibility.							
		Fresh or air-dry substance.						Water-free substance.				Fresh or air-dry substance.				Water-free substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
I. Green Fodders.																			
Corn fodder,	33	75.	1.2	5.2	0.5	2.0	16.1	20.8	2.0	8.0	64.4	2.7	0.4	1.1	12.1	10.6	1.6	4.3	48.3
Sorghum,	6	83.	1.2	4.6	0.3	1.5	9.4	27.0	1.8	8.8	55.3	2.7	0.2	0.7	7.0	15.9	1.3	4.0	41.0
Commou millet,	9	65.	1.7	11.0	1.0	2.6	18.7	31.4	2.9	7.4	53.4	-	-	-	-	-	-	-	-
Japanese millet (*Panicum italicum*),	12	75.	1.5	7.8	0.5	2.1	13.1	31.2	2.0	8.2	52.5	-	-	-	-	-	-	-	-
Panicum miliaceum,	1	69.	1.7	8.2	1.2	1.8	18.1	26.5	3.8	5.8	58.4	-	-	-	-	-	-	-	-
Barn-yard millet (*Panicum crus-galli*),	2	75.	1.9	7.0	0.6	2.4	13.1	27.9	2.5	9.7	52.2	-	-	-	-	-	-	-	-
Summer rape,	1	86.	2.6	2.5	0.5	2.0	6.4	17.8	3.6	14.3	45.7	-	-	-	-	-	-	-	-
Winter rape,	1	86.	3.1	1.7	0.5	2.1	6.6	12.1	3.6	15.0	47.1	-	-	-	-	-	-	-	-
Dwarf Essex rape,	1	86.	2.2	2.7	0.6	1.8	6.7	19.3	4.3	12.9	47.8	-	-	-	-	-	-	-	-
Green oats,	6	74.	2.1	7.8	0.8	3.6	11.7	30.0	3.1	13.8	45.0	4.4	0.5	2.5	8.5	16.8	1.9	9.7	32.9
Green barley,	1	79.	1.8	7.9	0.6	2.7	8.0	37.6	2.8	12.9	38.1	4.4	0.4	1.9	5.8	21.1	1.7	9.0	27.8
Green rye,	2	72.	1.6	8.9	0.6	2.1	14.8	31.8	2.1	7.5	52.9	5.0	0.4	1.5	10.8	17.8	1.3	5.3	38.6
Timothy,	2	65.	1.7	11.3	0.7	3.2	18.1	32.3	2.0	9.1	51.7	5.9	0.4	1.5	11.4	16.8	1.2	4.4	32.6

Hungarian grass,	2	74.	2.1	7.0	0.5	2.6	13.8	26.9	1.9	10.0	53.1	4.8	0.3	1.6	9.1	18.3	1.0	6.2	35.0
Vetch and oats (1 to 1),	1	82.	1.7	5.4	0.5	3.0	7.4	30.0	2.8	16.7	41.1	-	-	-	-	-	-	-	-
Vetch and oats (1 to 4),	1	79.	1.9	6.3	0.8	2.8	9.2	30.0	3.8	13.3	43.8	-	-	-	-	-	-	-	-
Peas and oats,	2	84.	1.3	4.7	0.5	2.4	7.1	29.4	3.1	15.0	44.4	2.8	0.2	1.8	4.3	17.6	1.4	11.6	27.1
Barley and peas,	1	84.	1.3	5.4	0.5	2.2	6.6	33.8	3.1	13.8	41.2	3.2	0.2	1.7	4.0	20.3	1.4	10.6	29.1
Horse bean,	1	85.	0.9	4.3	0.4	2.5	6.9	28.6	2.7	16.7	46.0	-	-	-	-	-	-	-	-
Flat pea,	2	79.	1.9	5.2	0.9	6.1	6.9	24.8	4.3	29.0	32.9	-	-	-	-	-	-	-	-
Cow pea,	3	82.	1.7	3.9	0.7	3.1	8.6	21.7	3.9	17.2	47.8	-	-	-	-	-	-	-	-
Soy bean,	14	76.	2.5	6.5	1.1	4.2	9.7	27.1	4.6	17.5	40.4	3.7	0.3	3.0	6.7	16.5	1.3	12.4	27.9
Soy bean (early white),	4	70.	3.9	6.7	0.8	5.0	13.6	22.3	2.7	16.7	45.3	-	-	-	-	-	-	-	-
Soy bean (medium green),	1	70.	3.9	7.1	1.2	5.8	12.0	23.7	4.0	19.3	40.0	-	-	-	-	-	-	-	-
Soy bean (medium black)	2	75.	3.1	5.9	1.3	4.7	10.0	23.4	5.2	18.9	39.9	-	-	-	-	-	-	-	-
Soy bean (late),	4	74.	3.5	5.5	0.7	5.9	10.4	21.1	2.7	22.7	40.0	-	-	-	-	-	-	-	-
Bokhara or sweet clover,	3	79.	2.1	6.3	0.6	4.2	7.8	30.0	2.9	20.0	37.1	-	-	-	-	-	-	-	-
Serradella,	3	82.	1.9	5.3	0.4	2.6	7.8	29.5	2.2	14.4	43.3	-	-	-	-	-	-	-	-
Common vetch,	2	82.	1.5	5.5	0.4	2.7	7.9	30.6	2.2	15.0	43.9	-	-	-	-	-	-	-	-
Hairy vetch,	1	82.	1.5	5.7	0.2	3.6	7.0	31.6	1.1	20.0	38.9	-	-	-	-	-	-	-	-
Kidney vetch,	1	81.	2.6	2.9	0.7	3.5	9.3	15.3	3.7	18.4	48.9	-	-	-	-	-	-	-	-
Prickly comfrey,	1	87.	2.8	1.5	0.3	2.3	6.1	11.5	2.4	17.7	46.9	-	-	-	-	-	-	-	-
Spurry,	1	72.	2.6	7.0	0.1	2.9	15.4	25.0	0.4	10.3	55.0	-	-	-	-	-	-	-	-
Scotch tares,	1	82.	2.2	5.1	0.3	3.5	6.9	28.3	1.7	19.5	38.3	-	-	-	-	-	-	-	-

A. *Composition and Digestibility of Cattle Feeds* — Continued.

NAME.	Analyses.	Composition.										Digestibility.							
		Fresh or air-dry substance.						Water-free substance.				Fresh or air-dry substance.				Water-free substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
II. Ensilages.																			
Corn ensilage,	39	78.	1.2	6.0	0.8	1.9	12.1	27.3	3.6	8.6	55.0	4.1	0.6	1.0	8.0	18.6	2.8	4.6	37.9
Corn and soy-bean ensilage,	4	76.	2.4	7.2	0.8	2.5	11.1	30.0	3.3	10.4	46.3	4.7	0.7	1.6	8.3	19.5	2.7	6.8	34.7
Millet ensilage,	3	74.	2.4	7.5	0.8	1.7	13.6	28.8	3.1	6.5	52.3	-	-	-	-	-	-	-	-
Millet and soy-bean ensilage,	9	79.	2.8	7.2	1.0	2.8	7.2	34.3	4.8	13.3	34.3	-	-	-	-	-	-	-	-
Apple-pomace ensilage,	1	85.	0.6	3.3	1.1	1.2	8.8	22.0	7.3	8.0	58.7	-	-	-	-	-	-	-	-
III. (a) Hay and Dry Coarse Fodders.																			
Corn fodder,	4	20.	4.1	23.4	1.4	6.2	44.9	29.2	1.7	7.7	56.3	15.2	1.0	3.7	33.2	19.0	1.3	4.5	41.7
Corn stover,	30	20.	4.7	28.3	1.1	5.9	40.0	35.4	1.4	7.3	50.0	19.0	0.6	3.1	25.6	23.7	0.7	3.8	32.0
English hay (mixed grasses),	66	14.	5.3	26.9	2.4	8.1	43.3	31.3	2.8	9.4	50.3	16.1	1.2	4.8	25.5	18.8	1.4	5.5	29.7
Fermented hay,	1	14.	6.3	25.4	2.2	8.4	43.7	29.5	2.6	9.8	50.8	-	-	-	-	-	-	-	-
Canada hay,	4	14.	4.6	28.1	2.1	6.1	45.1	32.7	2.4	7.1	52.4	14.6	1.3	2.9	28.4	17.0	1.4	3.4	33.0
Rowen,	15	17.	5.9	22.2	3.0	10.5	41.4	26.7	3.6	12.7	49.9	14.7	1.4	7.2	26.9	17.6	1.7	8.8	32.4

Timothy,	6	14.	4.2	28.3	1.9	8.5	43.1	32.9	2.2	9.9	50.1	14.7	1.1	4.1	27.2	17.1	1.3	4.8	31.6
Red-top,	4	14.	4.3	28.3	1.4	6.8	45.2	32.9	1.6	7.9	52.6	17.3	0.7	4.1	24.4	20.1	0.8	4.8	32.6
Kentucky blue-grass,	2	14.	7.2	29.7	1.8	7.5	39.8	34.5	2.1	8.7	46.3	-	-	-	-	-	-	-	-
Orchard grass,	4	14.	6.1	30.0	2.5	8.1	39.3	34.9	2.9	9.4	45.7	19.2	1.4	4.9	21.4	22.3	1.6	5.6	25.6
Meadow fescue,	5	14.	7.9	31.7	1.6	5.8	39.0	36.9	1.9	6.7	45.3	-	-	-	-	-	-	-	-
Perennial rye-grass,	4	14.	7.9	25.4	2.1	10.1	40.5	29.5	2.4	11.8	47.1	-	-	-	-	-	-	-	-
Italian rye-grass,	4	14.	6.5	28.6	1.6	7.1	42.2	33.2	1.9	8.4	49.0	-	-	-	-	-	-	-	-
Hungarian grass,	1	14.	4.9	27.5	1.9	8.2	43.5	31.9	2.3	9.5	50.6	18.7	1.2	4.9	29.1	21.7	1.5	5.7	33.9
Barn-yard grass,	1	14.	8.6	29.0	1.7	13.1	33.6	33.7	2.0	15.2	39.1	-	-	-	-	-	-	-	-
Black grass (salt) (*Juncus Gerardi*),	2	16.	7.7	24.4	2.4	6.8	42.7	29.0	2.9	8.1	50.8	14.6	1.0	4.3	23.9	17.4	1.2	5.1	28.4
High-grown salt hay (largely *spartina juncea*).	1	16.	7.0	22.2	2.1	6.3	46.4	26.4	2.5	7.5	55.3	11.1	1.0	4.0	24.6	13.2	1.2	4.7	29.3
Branch grass (salt) (largely *spartina juncea*),	1	16.	8.8	22.3	1.8	7.0	44.1	26.6	2.2	8.3	52.4	11.6	0.6	4.3	23.8	13.8	0.7	5.1	28.3
Low meadow fox grass (salt) (*spartina juncea*).	1	16.	5.4	22.3	2.2	6.0	48.1	26.5	2.6	7.2	57.3	11.4	0.5	3.0	25.0	13.5	0.6	4.1	29.8
Salt hay (variety unknown),	2	16.	4.3	24.0	2.5	3.4	49.8	28.6	3.0	4.0	59.3	-	-	-	-	-	-	-	-
Swamp or swale hay,	2	14.	5.8	26.7	1.9	7.1	44.5	31.0	2.2	8.3	51.8	8.8	0.8	2.4	20.5	10.2	1.0	2.8	23.8
Vetch and oats (1 to 1),	1	14.	8.1	25.8	2.4	14.4	35.3	30.0	2.8	16.7	41.1	-	-	-	-	-	-	-	-
Vetch and oats (1 to 4),	1	14.	7.8	25.8	3.3	11.4	37.7	30.0	3.8	13.3	43.8	17.0	2.6	6.8	20.4	19.8	3.0	8.0	23.7
Vetch and barley,	2	14.	5.3	27.9	2.0	11.9	38.9	32.4	2.3	13.8	45.2	18.4	1.6	7.1	21.0	21.4	1.8	8.3	24.4
Oats in bloom,	1	15.	5.6	30.6	2.4	5.5	40.9	36.0	2.8	6.5	48.1	17.1	1.5	3.9	29.9	20.2	1.7	4.6	35.1
Oats in milk,	1	15.	5.2	29.2	2.3	9.3	39.0	34.4	2.7	10.9	45.9	16.4	1.4	6.5	28.5	19.3	1.7	7.6	33.5
Oats, ripe,	1	15.	5.3	30.9	2.2	5.2	41.4	36.4	2.6	6.1	48.7	-	-	-	-	-	-	-	-
Winter rye in bloom,	1	15.	5.4	28.1	2.2	9.1	40.2	33.0	2.6	10.7	47.3	-	-	-	-	-	-	-	-

A. *Composition and Digestibility of Cattle Feeds* — Continued.

NAME.	Analyses.	Composition: Fresh or Air-Dry Substance.						Composition: Water-Free Substance.				Digestibility: Fresh or Air-Dry Substance.				Digestibility: Water-Free Substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
III. (a) Hay and Dry Coarse Fodders — Con.																			
Barley in milk,	1	15.	4.2	24.7	2.4	8.8	44.9	29.0	2.8	10.4	52.8	13.8	1.5	6.2	32.8	16.2	1.7	7.3	38.5
Common millet,	6	15.	4.3	28.3	1.8	6.6	44.0	33.3	2.1	7.8	51.8	-	-	-	-	-	-	-	-
Japanese millet,	3	15.	4.7	30.1	1.8	5.1	43.3	35.4	2.1	6.0	50.9	-	-	-	-	-	-	-	-
III. (b) Legumes.																			
Mammoth red clover,	5	15.	8.1	24.4	1.8	13.1	37.6	28.7	2.1	15.4	44.2	-	-	-	-	-	-	-	-
Medium red clover,	4	15.	7.3	26.0	2.4	11.8	37.5	30.6	2.7	13.9	44.1	12.0	1.3	6.5	24.0	14.1	1.4	7.6	28.2
Alsike clover,	8	15.	9.8	23.1	2.1	14.0	36.0	27.2	2.5	16.5	42.4	12.2	1.1	9.2	25.6	14.4	1.3	10.9	30.1
Lucerne (alfalfa),	6	15.	6.8	26.1	1.6	11.6	38.9	30.7	1.9	13.6	45.8	11.2	0.8	8.0	28.0	13.2	0.9	9.4	33.0
Sand lucerne,	1	15.	8.3	18.0	2.2	13.9	42.6	21.2	2.6	16.4	50.0	-	-	-	-	-	-	-	-
English gray pea,	1	15.	8.2	25.7	2.7	17.5	30.9	30.2	3.2	20.6	36.4	-	-	-	-	-	-	-	-
Canada beauty pea,	1	15.	6.7	24.7	2.3	18.7	37.6	29.0	2.7	16.1	44.3	-	-	-	-	-	-	-	-
Sainfoin,	1	15.	7.3	20.4	3.0	14.8	39.5	24.0	3.5	17.4	46.5	-	-	-	-	-	-	-	-

III. (c) Straw.																			
Wheat straw,	1	15.	4.1	30.5	1.4	6.2	42.8	35.9	1.6	7.3	50.4	15.9	0.4	0.7	16.3	18.7	0.5	0.8	19.2
Barley straw,	2	15.	4.8	32.2	2.5	6.5	39.0	37.9	2.9	7.7	45.9	18.0	1.1	1.3	21.1	21.2	1.2	1.5	24.8
Millet straw,	1	15.	5.8	35.5	1.2	4.2	38.3	41.8	1.4	4.9	45.1	-	-	-	-	-	-	-	-
Straw (*P. crus-galli*),	1	15.	4.6	30.4	2.1	5.2	42.7	35.8	2.5	6.1	50.2	-	-	-	-	-	-	-	-
Straw (*P. miliaceum*),	1	15.	5.2	35.9	2.5	3.3	38.1	42.2	3.0	3.9	44.8	-	-	-	-	-	-	-	-
Straw (*P. Italicum*),	1	15.	5.3	35.2	1.4	3.6	39.5	41.4	1.7	4.2	46.5	-	-	-	-	-	-	-	-
Soy-bean straw,	3	15.	6.1	36.1	1.8	4.7	36.3	42.5	2.1	5.5	42.7	13.7	0.1	2.4	24.0	16.2	1.3	2.8	28.2
Horse-bean straw,	1	15.	8.1	35.2	1.3	8.3	32.1	41.4	1.5	9.8	37.8	13.7	0.7	4.1	20.5	16.1	0.8	4.8	24.2
III. (d) Miscellaneous.																			
Teosinte,	1	15.	6.0	24.5	1.1	8.2	45.2	28.8	1.3	9.6	53.2	-	-	-	-	-	-	-	-
Sulla,	2	15.	7.9	17.6	2.3	14.5	42.7	20.7	2.7	17.1	50.2	-	-	-	-	-	-	-	-
Hairy lotus,	2	15.	7.0	16.8	2.5	12.6	46.1	19.8	3.0	14.8	54.2	-	-	-	-	-	-	-	-
White daisy,	1	15.	6.0	30.7	2.0	6.6	39.7	36.1	2.4	7.8	46.7	14.1	1.2	3.8	26.6	16.6	1.5	4.5	31.3
Carrot tops,	1	15.	11.8	11.6	1.7	18.0	41.9	13.6	2.0	21.2	49.3	-	-	-	-	-	-	-	-
IV. Roots, Tubers, Fruits, etc.																			
Beets, red,	7	88.	1.1	0.7	0.1	1.5	8.6	5.8	0.8	12.5	71.7	0.5	0.1	1.4	8.6	4.3	0.4	11.4	71.7
Beets, sugar,	12	86.	0.8	0.9	0.1	1.5	10.7	6.4	0.7	10.7	76.5	0.7	0.1	1.4	10.7	4.8	0.4	9.7	76.5
Beets, yellow fodder,	4	89.	1.0	1.0	0.2	1.3	7.5	9.1	1.8	11.8	68.2	0.8	0.1	1.2	7.5	6.8	0.9	10.7	68.2
Mangolds,	5	88.	1.2	0.8	0.1	1.4	8.5	6.7	0.8	11.7	70.8	0.6	0.1	1.3	8.5	5.0	0.4	10.6	70.8
Turnips,	5	90.	0.9	1.2	0.2	1.1	6.6	12.0	2.0	11.0	66.0	0.9	0.2	1.0	6.4	9.0	2.0	9.9	64.0

A. *Composition and Digestibility of Cattle Feeds* — Continued.

NAME.	Analyses.	Composition.										Digestibility.							
		Fresh or Air-Dry Substance.						Water-Free Substance				Fresh or Air Dry Substance.				Water-Free Substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
IV. Roots, Tubers, Fruits, etc. — Con.																			
Ruta-bagas,	3	89.	1.1	1.3	0.2	1.2	7.2	11.8	1.8	10.9	65.5	1.0	0.2	1.0	6.8	8.8	1.5	8.7	62.2
Carrots,	5	89.	0.9	1.1	0.2	1.0	7.8	10.0	1.8	9.1	70.9	-	-	-	-	-	-	-	-
Parsnips,	1	80.	1.5	1.5	0.7	1.3	15.0	7.5	3.5	6.5	75.0	-	-	-	-	-	-	-	-
Potatoes,	14	81.	1.0	0.5	0.1	1.9	15.5	2.6	0.5	10.0	81.6	-	-	0.8	14.1	-	-	4.4	74.2
Artichokes,	1	78.	1.1	0.9	0.2	2.9	16.9	4.1	0.9	13.1	76.9	-	-	-	-	-	-	-	-
Apples,	2	78.	0.7	1.5	0.5	1.0	18.3	6.8	2.3	4.5	83.2	-	-	-	-	-	-	-	-
Apple pomace,	3	83.	0.4	2.9	0.8	1.2	11.7	17.0	4.7	7.1	68.8	-	-	-	-	-	-	-	-
Sugar-beet pulp,	1	90.	0.1	2.5	0.1	1.4	5.9	25.0	1.0	14.0	59.0	-	-	-	-	-	-	-	-
Cranberries,	1	89.	0.2	1.2	0.6	0.5	8.5	10.9	5.5	4.5	77.3	-	-	-	-	-	-	-	-
Japanese radish (*merinia*),	1	93.	0.7	0.7	0.1	0.5	5.0	10.0	1.4	7.1	71.5	-	-	-	-	-	-	-	-
Japanese radish (*niyas-hige*),	1	93.	0.7	0.7	0.1	0.5	5.0	10.0	1.4	7.1	71.5	-	-	-	-	-	-	-	-
V. Grains, Seeds, etc.																			
Corn kernels,	29	10.6	1.5	1.9	4.8	10.9	70.3	2.1	5.3	12.2	78.8	-	-	-	-	-	-	-	-
Sweet corn kernels,	1	12.0	1.4	2.1	8.4	11.1	65.0	2.4	9.5	12.6	73.9	-	-	-	-	-	-	-	-

Wheat kernels,	3	10.6	1.8	2.2	1.7	12.4	71.3	2.5	1.9	13.9	79.7	-	-	-	-	-	-	-	-
Oat kernels,	3	10.8	3.0	8.5	5.5	13.6	58.6	9.5	6.2	15.3	65.6	1.8	3.9	11.7	43.4	2.0	4.4	13.6	48.5
Broom-corn seed,	1	14.1	2.2	7.1	3.5	9.6	63.5	8.3	4.0	11.2	73.9	-	-	-	-	-	-	-	-
Soy beans,	4	13.0	5.1	5.0	17.2	31.2	28.5	5.7	19.8	35.8	32.8	2.5	14.6	28.1	20.5	2.8	16.8	32.2	23.6
Red adzinki beans,	2	15.9	3.5	3.9	0.7	20.6	55.4	4.7	0.8	24.4	65.9	-	-	-	-	-	-	-	-
Saddle beans,	1	12.4	5.4	4.2	14.5	13.2	50.3	4.8	16.5	15.1	57.4	-	-	-	-	-	-	-	-
Horse beans,	1	10.3	3.9	7.3	0.9	26.9	50.7	8.1	1.0	30.0	56.5	5.3	0.8	23.7	47.2	5.8	0.9	26.4	52.5
Millet seed,	3	13.3	2.6	7.7	3.7	11.4	61.3	8.9	4.3	13.2	70.6	-	-	-	-	-	-	-	-
Barn-yard millet seed (*P. crus-galli*),	1	10.3	3.1	7.7	5.7	12.3	60.9	8.6	6.3	13.7	67.7	-	-	-	-	-	-	-	-
Chestnuts,	1	44.9	1.5	1.4	8.0	7.3	36.9	2.5	14.5	13.3	67.0	-	-	-	-	-	-	-	-
VI. Flour and Meal.																			
Corn meal,	40	13.6	1.4	1.9	3.4	9.6	70.1	2.2	3.9	11.1	81.1	-	3.1	5.8	65.2	-	3.6	6.7	75.4
Corn and cob meal,	37	10.5	1.4	6.7	3.7	9.0	68.7	7.5	4.1	10.0	76.8	3.0	3.0	0.5	60.5	3.4	3.4	5.2	67.5
Cooked feed (oats and corn),	1	5.5	3.8	8.2	5.0	14.0	63.5	8.6	5.0	14.8	67.6	-	-	-	-	-	-	-	-
Ground wheat,	1	11.5	2.0	2.9	2.0	12.1	69.5	3.3	2.2	13.7	78.6	-	-	-	-	-	-	-	-
Ground oats,	2	9.3	3.5	8.5	3.6	11.4	63.7	9.4	4.0	12.6	70.2	1.7	3.0	8.9	48.4	1.9	3.3	9.9	53.4
Ground barley,	5	13.1	2.4	5.7	1.9	11.3	65.6	6.5	2.2	13.0	75.6	2.9	1.7	7.9	64.0	3.3	2.0	9.1	69.6
Broom-corn meal,	1	13.5	2.1	6.9	3.5	9.7	64.3	8.0	4.1	11.2	74.3	-	-	-	-	-	-	-	-
Pea meal,	1	8.8	2.6	17.7	1.6	19.2	50.1	19.4	1.8	21.0	54.9	4.6	0.9	15.9	47.1	5.0	1.0	1.7	51.6
Peanut meal,	1	8.0	4.0	3.5	10.8	49.0	24.7	3.8	11.8	53.3	26.8	0.8	9.6	44.6	22.7	0.9	10.5	48.5	24.7
"Red dog" flour,	1	9.7	1.9	1.4	4.4	22.6	60.0	1.6	4.9	25.0	66.4	-	-	-	-	-	-	-	-

A. *Composition and Digestibility of Cattle Feeds* — Continued.

NAME.	Analyses.	Composition.										Digestibility.							
		Fresh or Air-dry Substance.						Water-free Substance.				Fresh or Air-dry Substance.				Water-free Substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
VI. Flour and Meal — Concluded.																			
Bean meal,	1	12.0	1.4	2.1	8.5	11.0	65.0	2.4	9.7	12.5	73.8	1.5	7.3	9.7	60.5	1.7	8.3	11.0	68.6
Soy-bean meal,	1	9.2	5.0	3.9	16.3	34.8	30.8	4.3	18.0	38.3	33.9	2.0	13.9	31.3	22.2	2.9	15.3	54.5	24.4
VII. (a) By-products and Refuse.																			
Cotton-seed meal,	36	8.0	6.9	6.7	10.7	42.0	25.7	7.3	11.6	45.6	27.9	2.1	10.0	37.0	16.4	2.3	10.8	40.1	17.9
Cotton-seed meal (meats and hull),	1	7.8	3.6	19.8	6.7	26.4	35.7	21.4	7.2	28.7	38.8	-	-	-	-	-	-	-	-
Linseed meal, old process,*	9	9.7	6.0	7.6	6.6	33.5	36.6	8.4	7.3	37.1	40.5	4.3	5.9	29.8	28.5	4.8	6.5	33.0	31.6
Cleveland linseed meal,	8	8.3	5.9	8.5	2.9	36.1	38.3	9.3	3.2	39.3	41.8	6.3	2.7	30.7	32.2	6.9	3.0	33.4	35.1
Clevelaud flax meal,	1	9.9	5.3	7.6	2.5	40.2	34.5	8.4	2.8	44.6	38.3	-	-	-	-	-	-	-	-
Cocoanut meal,	1	9.3	5.2	17.1	11.7	20.5	36.2	18.8	12.9	22.6	40.0	-	-	-	-	-	-	-	-
VII. (b) Gluten Products.																			
Chicago gluten meal, old process,	3	9.2	0.8	1.1	6.2	30.4	52.3	1.2	6.8	33.5	57.6	-	5.8	27.1	48.6	-	6.3	29.8	53.6
Chicago gluten meal, new process,	6	9.2	1.3	2.5	6.1	37.8	43.1	2.8	6.7	41.5	47.4	-	5.7	33.6	40.1	-	6.2	36.9	44.1

King gluten meal,	3	7.7	1.9	1.4	19.0	35.4	34.6	1.5	20.6	38.4	36.4	-	17.9	32.2	27.3	-	19.4	34.9	28.8
Pope gluten meal (cream),	2	8.0	0.6	1.7	10.2	36.2	43.3	1.8	11.1	39.3	47.1	-	10.0	30.4	38.1	-	10.9	33.0	41.4
Iowa gluten meal (golden),	1	4.8	1.2	6.9	12.9	25.7	48.5	7.2	13.5	27.0	51.0	5.4	10.2	21.3	43.7	5.6	10.7	22.4	45.9
Hammond gluten meal,	1	8.2	1.1	1.5	9.7	29.9	49.6	1.6	10.6	32.6	54.0	-	9.0	26.6	46.1	-	9.9	29.0	50.2
Gluten meal (varieties uncertain),	38	9.0	0.9	3.3	8.3	27.3	51.2	3.6	9.1	30.0	56.3	-	7.6	24.3	45.1	-	8.4	26.7	49.5
Buffalo gluten feed,	18	8.2	0.9	6.8	11.5	23.2	49.4	7.4	12.5	25.2	53.6	5.3	9.1	19.3	44.5	5.8	9.9	20.9	48.2
Buffalo gluten feed,†	1	10.5	2.6	6.7	4.4	27.1	48.7	7.5	4.9	30.3	54.4	5.2	3.3	22.5	43.8	5.8	3.9	25.1	49.0
Peoria gluten feed,	8	6.9	0.6	7.4	11.5	21.4	52.2	8.0	12.4	23.0	56.1	5.8	9.1	17.8	47.0	6.2	9.8	19.1	50.5
Pope gluten feed,	2	8.0	1.3	6.3	8.4	25.3	50.7	6.9	9.1	27.5	55.1	4.9	6.6	21.0	45.6	5.4	7.2	22.8	49.6
Diamond gluten feed,	1	8.4	1.1	7.3	10.2	22.0	51.0	8.0	11.1	24.0	55.7	5.7	8.1	18.3	45.9	6.2	8.8	19.9	50.1
Chicago maize feed,	5	8.2	0.6	7.5	7.1	24.9	51.7	8.2	7.7	27.1	56.3	5.4	6.4	20.9	43.9	5.9	6.9	22.8	47.9
Starch feed (Pope),	1	5.5	0.8	14.5	10.7	10.7	57.8	15.2	11.3	11.3	61.3	-	-	-	-	-	-	-	-
Glucose feed (Richardson),	1	6.3	1.0	11.0	11.0	21.6	49.1	11.7	11.7	23.1	52.4	-	-	-	-	-	-	-	-
Corn germ feed,	1	7.5	0.8	13.0	11.3	10.0	57.4	14.1	12.2	10.8	62.0	-	-	-	-	-	-	-	-
Atlas gluten feed,	9	7.5	1.7	11.0	12.6	31.5	35.7	11.9	13.6	34.1	38.6	11.0	11.5	23.0	30.0	11.9	12.4	24.9	32.4
Corn screenings,	1	11.1	2.1	2.9	4.0	7.4	72.5	3.3	4.5	8.3	81.5	-	-	-	-	-	-	-	-
Dried brewer's grain,	5	9.0	3.8	10.6	4.9	22.8	48.9	11.7	5.4	25.1	53.7	5.6	4.5	18.0	28.9	6.2	4.9	19.8	31.7
Wet brewer's grain,	1	77.0	0.7	3.8	2.0	6.7	9.8	16.7	8.5	29.0	42.5	-	-	-	-	-	-	-	-
Malt sprouts,	2	12.0	5.2	12.8	2.6	24.3	43.1	14.6	3.0	27.6	49.0	4.4	2.6	19.4	29.7	5.0	3.0	22.1	33.8

* National Linseed Oil Company.

† Improved process.

A. *Composition and Digestibility of Cattle Feeds* — Continued.

NAME.	Analyses.	Composition.										Digestibility.							
		Fresh or Air-dry Substance.						Water-free Substance				Fresh or Air-dry Substance				Water-free Substance.			
		Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
VII. (c) Brans and Middlings.																			
Cotton hull bran,	1	11.	1.9	35.0	1.1	2.3	48.7	39.3	1.2	2.6	54.7	-	-	-	-	-	-	-	-
Spring wheat bran,	4	11.	5.7	10.4	5.0	15.9	52.0	11.7	5.6	17.9	58.4	2.5	3.8	12.7	36.4	2.8	4.2	14.3	40.9
Winter wheat bran,	3	11.	6.2	8.5	2.9	15.1	56.3	9.6	3.2	17.0	63.3	2.3	1.9	11.6	36.6	2.6	2.0	13.1	41.1
Wheat bran (average),	53	11.	6.7	9.6	4.5	16.1	52.1	10.8	5.0	18.1	58.5	2.1	3.2	12.6	35.4	2.4	3.6	14.1	39.8
Heavy bran (bran and flour),	2	11.	4.1	7.2	4.5	16.8	56.4	8.1	5.1	18.4	63.4	-	-	-	-	-	-	-	-
Boston mixed feed,	1	11.	4.8	6.3	4.6	19.2	54.1	7.1	5.2	21.6	60.8	-	-	-	-	-	-	-	-
"Imperial mill" mixed feed,	1	11.	3.1	5.1	4.5	15.0	61.3	5.7	5.0	16.9	68.8	-	-	-	-	-	-	-	-
Quincy mixed feed,	1	11.	4.8	6.9	5.1	16.5	55.7	7.8	5.7	18.5	62.6	-	-	-	-	-	-	-	-
Rye bran,	2	11.	4.1	3.5	2.3	15.6	63.5	4.0	2.6	17.8	71.3	-	-	-	-	-	-	-	-
Pea bran,	1	11.	2.9	41.1	1.1	9.2	34.7	46.2	1.2	10.3	39.0	-	-	-	-	-	-	-	-
Louisiana rice bran,	1	11.	9.4	13.3	8.6	8.7	49.0	14.9	9.7	9.8	55.0	-	-	-	-	-	-	-	-
Wheat middlings,	11	11.	5.1	6.6	4.8	15.8	56.7	7.4	5.4	17.8	63.7	23.8	4.1	13.4	49.9	2.7	4.6	15.1	56.1
Rye middlings,	1	11.	3.6	3.3	5.0	11.7	65.4	3.7	5.6	13.2	73.5	-	-	-	-	-	-	-	-

Oat middlings,	1	11.	4.2	17.4	3.3	10.8	53.3	19.5	3.7	12.1	59.9	-	-	-	-	-	-	-	-
Buckwheat middlings,	1	11.	4.8	4.6	6.7	22.7	50.2	5.2	7.5	25.5	56.4	-	-	-	-	-	-	-	-
VII. (d) Miscellaneous.																			
Cotton hulls,	4	11.	2.6	40.2	2.8	5.8	37.6	45.2	3.1	6.5	42.2	18.9	2.2	3.2	12.8	21.2	2.4	3.7	14.3
Cotton-seed feed,	2	10.	3.0	37.6	3.4	10.4	35.6	41.8	3.8	11.6	39.5	-	-	-	-	-	-	-	-
Hominy meal (previous to 1891),	4	8.	2.3	3.9	9.0	9.6	67.2	4.3	9.8	10.4	73.1	-	-	-	-	-	-	-	-
Hominy chop or meal,*	1	7.8	2.9	4.3	9.8	11.8	63.4	4.6	10.6	12.8	68.9	-	-	-	-	-	-	-	-
Cerealine,	2	10.	2.7	5.4	8.9	12.1	60.9	6.0	9.9	13.4	67.7	-	-	-	-	-	-	-	-
Rice meal,	2	10.2	8.1	5.4	13.1	12.0	51.2	6.0	14.6	13.2	57.0	-	11.9	7.4	47.1	--	13.3	8.2	52.4
Excelsior feed,	1	7.1	4.1	13.7	5.0	9.1	61.0	14.7	5.4	9.8	65.7	-	-	-	-	-	-	-	-
Oat feed,	20	7.5	5.0	15.1	4.0	11.1	57.3	16.3	4.3	12.0	61.9	-	-	-	-	-	-	-	-
Proteina,	4	8.4	2.5	10.0	6.6	21.7	50.8	10.9	7.2	23.7	55.5	-	-	-	-	-	-	-	-
Hall's dairy feed,	1	7.2	6.1	10.2	9.5	20.8	46.2	11.0	10.2	22.4	49.8	-	-	-	-	-	-	-	-
Rye feed,	2	8.9	2.7	3.3	2.6	13.8	68.7	3.6	2.9	15.1	75.4	-	-	-	-	-	-	-	-
Peanut feed,	2	10.0	2.6	56.4	5.5	8.9	16.6	62.7	6.1	9.9	18.4	6.8	5.0	6.3	8.1	7.5	5.5	7.0	9.0
Peanut husks,	1	13.0	1.2	66.0	1.7	5.0	13.1	75.9	1.9	5.7	15.1	-	-	-	-	-	-	-	-
Bakery refuse,	1	13.3	10.1	0.3	5.5	8.0	62.8	0.4	6.4	9.2	72.4	-	-	-	-	-	-	-	-
Vinegar mash,	1	94.5	0.2	0.5	0.5	0.9	3.4	8.6	8.5	16.5	63.4	-	-	-	-	-	-	-	-
Refuse from starch works,	1	57.0	0.4	3.2	4.4	9.6	25.4	7.5	10.2	22.4	59.0	-	-	-	-	-	-	-	-
Glucose refuse,	1	6.7	1.1	4.5	9.9	19.7	58.1	4.8	10.6	21.1	62.3	-	-	-	-	-	-	-	-

* Recent analysis.

A. Composition and Digestibility of Cattle Feeds — Concluded.

NAME.	Analyses.	Composition. Fresh or air-dry substance. Water.	Ash.	Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Composition. Water-free substance. Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Digestibility. Fresh or air dry substance. Cellulose.	Fat.	Protein.	Nitrogen-free Extract.	Digestibility. Water-free substance. Cellulose.	Fat.	Protein.	Nitrogen-free Extract.
VII. (d) *Miscellaneous* — Concluded.																			
Damaged wheat,	1	18.1	2.0	2.7	2.2	14.2	65.8	3.1	2.5	16.3	75.8	-	-	-	-	-	-	-	-
Cocoa dust,	1	7.1	6.3	5.5	24.1	14.4	42.6	5.9	25.9	15.5	45.9	-	-	-	-	-	-	-	-
Broom corn waste,	1	8.7	4.5	35.9	0.9	6.1	43.9	39.3	1.0	6.8	48.0	-	-	-	-	-	-	-	-
Sugar-beet refuse,	1	28.9	5.3	5.8	0.3	8.6	51.1	8.1	0.4	12.1	71.9	-	-	-	-	-	-	-	-
Corn cobs,	6	7.6	1.3	31.4	0.5	2.7	56.5	34.0	0.6	2.9	61.1	20.4	0.3	0.5	33.9	22.1	0.3	0.5	36.7
Palmetto root,	1	11.5	3.9	18.9	0.4	3.4	61.9	21.3	0.5	3.8	70.0	-	-	-	-	-	-	-	-
Ground cloves,	2	12.2	7.4	28.1	2.0	13.2	37.1	32.0	2.3	15.0	42.3	-	-	-	-	-	-	-	-
Calf meal (Blatchford),	1	8.1	4.3	4.6	4.5	25.6	52.9	5.0	4.9	27.8	57.6	-	-	-	-	-	-	-	-
Animal meal (Bowker's),	1	5.1	28.6	-	16.2	40.0	-	-	17.1	42.2	-	-	-	-	-	-	-	-	-

B. *Fertilizing Ingredients in Fodder Articles.*

[Figures equal percentages or pounds in 100.]

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
I. Green Fodders.						
Corn fodder,	14	79.	.41	.33	.15	$1 45
Sorghum,	7	83.	.23	.23	.09	86
Barn-yard millet (*Panicum crus-galli*),	1	75.	.46	.49	.11	1 69
Japanese millet (*P. Italicum*),	3	63.	.61	.41	.19	2 05
Summer rape,	1	86.	.32	.73	.09	1 60
Green oats,	3	83.	.49	.38	.13	1 67
Green rye,	2	72.	.30	.64	.12	1 47
Hungarian grass,	1	74.	.39	.54	.16	1 62
Vetch and oats,	1	86.	.24	.79	.09	1 45
Horse bean,	1	75.	.68	.35	.08	2 05
Flat pea,	1	79.	1.05	.45	.14	3 10
Cow pea,	1	82.	.32	.18	.10	1 04
Small pea,	1	82.	.48	.37	.11	1 62
Soy bean,	1	73.	.29	.53	.15	1 36
Soy bean (early white),	1	67.	.94	.91	.21	3 36
Soy bean (medium green),	1	70.	.84	.71	.20	2 91
Soy bean (medium black),	1	77.	.80	.57	.18	2 65
Soy bean (late),	1	80.	.60	.68	.14	2 25
Bokhara or sweet clover,	1	79.	.45	.42	.13	1 62
Serradella,	2	83.	.41	.42	.14	1 53
Spring vetch,	1	85.	.36	.45	.10	1 40
Kidney vetch,	1	81.	.56	.35	.09	1 78
Prickly comfrey,	1	87.	.37	.76	.12	1 76
Common buckwheat,	1	85.	.44	.54	.09	1 67
Silver-hull buckwheat,	1	85.	.29	.39	.14	1 21
Japanese buckwheat,	1	85.	.26	.53	.14	1 08
Corn ensilage,	7	80.	.42	.39	.13	1 52
Corn and soy-bean ensilage,	1	71.	.79	.44	.42	2 51
Millet ensilage,	3	74.	.26	.62	.14	1 37
Millet and soy-bean ensilage,	5	76.	.48	.50	.12	1 76
II. Hay and Dry Coarse Fodders.						
Corn fodder,	7	20.	1.53	.77	.47	4 87
Corn stover,	17	20.	.92	1.22	.26	3 66

* Using the figures for the retail cost of nitrogen, phosphoric acid and potash in fertilizers, the amounts obtained show comparative rather than actual values, because the ingredients in fertilizers are easier to handle and in a more available form than in fodders.

B. Fertilizing Ingredients in Fodder Articles — Continued.

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
II. Hay and Dry Coarse Fodders — Con.						
English hay,	12	15.	1.27	1.50	.29	$4 81
Rowen,	13	15.	1.70	1.56	.46	6 05
Timothy,	3	15.	1.19	1.40	.33	4 55
Red top,	4	15.	1.06	.94	.33	3 78
Kentucky blue-grass,	2	15.	1.19	1.52	.39	4 73
Orchard grass,	4	15.	1.22	1.58	.38	4 85
Meadow fescue,	6	15.	.92	1.96	.37	4 50
Perennial rye-grass,	2	15.	1.15	1.45	.52	4 68
Italian rye-grass,	4	15.	1.11	1.18	.52	4 32
Salt hay,	1	15.	1.06	.65	.23	3 40
Millet,	1	15.	1.22	1.61	.46	4 95
Vetch and oats,	3	15.	1.23	1.27	.62	4 78
Mammoth red clover,	3	15.	2.14	1.16	.52	6 76
Medium red clover,	2	15.	2.01	2.11	.41	7 30
Alsike clover,	6	15.	2.26	2.10	.63	8 09
Lucerne (alfalfa),	4	15.	1.87	1.32	.48	6 04
Sainfoin,	1	15.	2.54	1.95	.73	8 69
Barley straw,	2	15.	.95	2.03	.19	4 48
Soy-bean straw,	1	15.	.69	1.04	.25	2 92
Millet straw,	1	15.	.68	1.73	.18	3 52
Teosinte,	1	15.	1.32	3.35	.16	6 66
White lupine,	1	15.	2.56	1.46	.29	7 87
Yellow lupine,	1	15.	2.28	2.51	.51	12 57
Spanish moss,	1	15.	.61	.56	.07	2 09
Sulla,	2	15.	2.31	1.96	.42	7 88
White daisy,	1	15.	.26	1.18	.41	2 17
Carrot tops,	1	15.	2.95	4.60	.57	12 19
III. Roots, Tubers, Fruits, etc.						
Beets, red,	8	88.	.24	.44	.09	1 10
Beets, sugar,	4	87.	.22	.48	.10	1 10
Beets, yellow fodder,	1	91.	.19	.46	.09	99
Mangolds,	3	88.	.15	.34	.14	83
Turnips,	4	90.	.17	.38	.12	90
Ruta-bagas,	3	89.	.19	.49	.12	1 03

* See note on page 151.

B. Fertilizing Ingredients in Fodder Articles — Continued.

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
III. Roots, Tubers, Fruits, etc. — Con.						
Carrots,	3	89.	.16	.46	.09	$0 93
Parsnips,	1	80.	.22	.62	.19	1 32
Potatoes,	4	80.	.29	.51	.08	1 29
Artichokes,	1	78.	.46	.48	.17	1 74
Apples,	2	80.	.13	.19	.01	51
Apple pomace,	2	81.	.23	.13	.02	70
Cranberries,	1	89.	.08	.10	.03	32
Japanese radish (*merinia*),	1	93.	.08	.28	.05	52
Japanese radish (*niyas hige*),	1	93.	.08	.34	.05	58
IV. Grains, Seeds, etc.						
Corn kernels,	13	10.9	1.82	.40	.70	5 04
Oat kernels,	1	9.0	2.10	–	–	–
Soy bean,	2	18.3	5.30	1.99	1.87	16 39
Red adzinki beans,	1	14.8	3.24	1.54	.94	10 16
White adzinki beans,	1	16.9	3.33	1.48	.97	10 35
Saddle beans,	1	12.3	2.12	2.13	1.52	8 59
Common millet,	2	11.5	2.01	.45	.96	6 02
Japanese millet,	1	13.7	1.73	.38	.69	5 15
Chestnuts,	1	45.0	1.18	.63	.39	3 79
V. Flour and Meal.						
Corn meal,	3	14.1	1.92	.34	.71	5 59
Corn and cob meal,	29	9.0	1.41	.47	.57	4 37
Wheat flour,	2	12.1	2.02	.36	.35	5 52
Ground barley,	1	13.4	1.55	.34	.66	4 65
Pea meal,	1	8.9	3.08	.99	.82	9 12
Soy-bean meal,	1	10.8	5.89	2.23	1.57	17 80
Peanut meal,	1	8.0	7.84	1.54	1.27	21 50
VI. By-products and Refuse.						
Cotton-seed meal,	24	8.2	6.70	1.83	2.47	20 13
Linseed meal (old process),	4	8.0	5.39	1.21	1.78	15 75
Cleveland linseed meal,	5	8.0	5.83	1.25	1.70	16 76
Gluten meal (Chicago),	2	9.6	6.04	.06	.43	14 74
Gluten meal (King),	1	7.8	5.69	.08	.69	14 36
Gluten meal (variety uncertain),	5	8.5	5.09	.05	.42	12 64

* See note on page 151.

B. Fertilizing Ingredients in Fodder Articles — Concluded.

NAME.	Analyses.	Water.	Nitrogen.	Potassium Oxide.	Phosphoric Acid.	Valuation per 2,000 Pounds.*
VI. By-products and Refuse — Con.						
Gluten feed (Buffalo),	5	8.2	3.72	.06	.34	$9 29
Atlas gluten feed,	1	11.2	4.80	.16	.23	11 89
Dried brewers' grain,	2	8.6	3.65	.85	1.05	10 76
Wheat bran,	10	9.9	2.36	1.40	2.10	8 95
Louisiana rice bran,	1	10.3	1.43	.84	1.71	5 81
Wheat middlings,	2	10.2	2.75	.75	1.25	8 48
Rye middlings,	1	12.5	1.84	.81	1.26	6 36
Buckwheat hulls,	1	11.9	.49	.52	.07	1 76
Cotton hulls,	3	10.6	.75	1.08	.18	3 05
Proteina,	1	10.1	2.97	.57	1.00	8 59
Rye feed,	1	9.6	1.95	.98	1.56	7 06
Peanut feed,	2	10.0	1.46	.79	.23	4 50
Peanut husks,	1	13.0	.80	.48	.13	2 52
Damaged wheat,	1	13.1	2.26	.51	.83	6 68
Glucose refuse,	1	6.7	3.37	.09	.61	8 73
Cocoa dust,	1	7.1	2.30	.63	1.34	7 36
Broom corn waste (stalks),	1	10.4	.87	1.86	.46	4 36
Corn cobs,	8	12.1	.50	.60	.06	1 85
Palmetto roots,	1	11.5	.54	1.38	.16	2 82
Meat meal,	1	8.0	11.21	.30	.73	27 86
VII. Dairy Products.						
Buttermilk,	1	91.1	.51	.05	.04	1 31
Skim-milk,	22	90.3	.59	–	–	–
Whey,	1	93.7	.10	.07	.17	47

* See note on page 151.

C. *Analyses of Dairy Products (Per Cent.).*

	Analyses.	Solids.			Fat.			Curd.	Salt.	Ash.
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.			
Whole milk,	2,173	18.27	10.20	13.52	7.54	1.72	4.20	3.51 [1]	-	.71 [2]
Skim-milk,	354	10.48	7.68	9.48	1.02	.05	.32	-	-	-
Buttermilk,	31	9.86	6.83	8.33	.38	.11	.27	-	-	-
Cream (from Cooley process),	203	32.78	18.12	26.10	25.00	10.53	17.60	-	-	.62
Cream (concentrated commercial),	2	50.12	48.71	49.41	45.63	32.20	42.33 [3]	-	-	-
Butter (salted),	39	92.89	85.35	89.21	89.05	81.43	84.36	1.17	3.43	-
Butter (fresh),	14	85.36	72.49	82.24	85.05	72.21	81.48	.76	-	-
Whole-milk cheese (Jersey),*	1	-	-	62.84	-	-	37.32	22.13	-	3.39
Whole-milk cheese,*	1	-	-	64.17	-	-	34.34	26.69	-	3.14
Cheese from milk skimmed after twelve hours' standing,*	1	-	-	62.70	-	-	27.81	30.37	-	4.52
Cheese from milk skimmed after twenty-four hours' standing,*	1	-	-	57.76	-	-	23.42	31.99	-	2.35
Cheese from milk skimmed after thirty-six hours' standing,*	1	-	-	56.05	-	-	17.67	33.24	-	5.14
Cheese from milk skimmed after forty-eight hours' standing,*	1	-	-	54.59	-	-	15.77	34.94	-	3.88
Cheese from skim-milk, with addition of buttermilk,*	1	-	-	51.62	-	-	18.35	28.63	-	4.64
Genuine oleomargarine cheese,*	1	-	-	62.10	-	-	31.66	25.94	-	4.50

* From analyses made in 1875: [1] Average of 42 determinations; [2] Average of 8 determinations; [3] Average of 5 determinations.

Tables of the Digestibility of American Feed Stuffs.

Experiments made in the United States.

Compiled by J. B. LINDSEY.

I. Experiments with Ruminants.

II. Experiments with Swine.

Dec. 31, 1896.

TABLES OF THE DIGESTIBILITY OF AMERICAN FEED STUFFS.

I. Experiments with Ruminants.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay and Dry Coarse Fodders.								
Timothy hay (in bloom),	3	5	55.6—65.7 60	56.4—66.8 60	55.8—62.1 58	51.5—61.8 57	50.3—60.4 56	57.5—71.8 63
Timothy hay (past bloom),	5	10	47.0—61.1 53	48.4—62.3 54	37.2—56.8 47	34.6—61.1 53	38.8—50.4 45	55.6—66.9 60
Timothy hay (average all trials),	12	26	57	58	52	60	48	63
Hay of mixed grasses (medium in protein*),	1	2	-	-	49	50	40	58
Hay of mixed grasses (rich in protein),	6	20	54—62 58	- -	56—66 60	44—57 48	56—64 58	56—63 59
Rowen (mixed grasses),	1	4	- -	63—67 65	65—68 66	44—50 46	68—70 69	63—68 65
Rowen (chiefly timothy),	1	4	- -	62—67 64	62—73 66	48—51 49	66—69 68	60—65 63
Average (both samples),	-	-	-	65	66	47	68	64
Salt hay of black grass (*Juncus Gerardi*),	1	2	57—62 60	- -	57—64 60	37—46 41	62—63 63	53—59 56
High-grown salt hay (largely *Spartina juncea*),	1	2	51—55 53	- -	46—55 50	42—51 47	62—63 63	52—55 53
Branch g[illegible] (*Spartina juncea*, with *Spartina stricta*, var. *glabra*),	1	2	55—57 56	- -	48—56 52	27—36 31	61—63 62	54—55 54
Low meadow fox grass (*Spartina juncea*),	1	2	52—54 53	- -	49—53 51	17—30 24	- 57	51—52 52

Meadow, swale or swamp hay,	1	2	38—40 39	- -	30—36 33	- 44	31—37 34	- 46
Hay of vetch and oats,	1	2	58—58 58	- -	65—67 66	17—20 19	60—61 60	54—54 54
Clover and timothy hay (poorly cured),	1	2	54.3—55.3 55	- -	52—54.4 53	- 58	37.5—37.9 38	- 60
Hungarian hay,	1	2	64.3—65.8 65	65.9—66.8 66	66.8—68.5 68	- 64	- 60	66.9—67.4 67
Hay of blue-joint grass (past bloom) (*Calamagrostis Canadensis*),	1	1	40	42	37	37	57	43
Hay of blue-joint grass (bloom),	1	2	66.7—70.5 69	68.1—71.5 70	71.5—73.4 72	51.4—53.3 52	68.2—72.3 70	66.4—70.9 69
Hay of orchard grass (ten days after bloom),	1	1	54	56	58	54	59	54
Hay of orchard grass (stage not given),	1	2	57.5—60 59	- -	60—66.7 64	55.4—57.4 56	60—60.8 60	55.3—57.3 56
Average of both samples,	2	3	56	56	61	55	60	55
Hay of red top,	2	3	57.6—62.3 60	59.3—63.6 61	60.8—61.8 61	44.2—58.8 51	60.4—62.4 61	59.1—65.2 62
Dried pasture grass,	1	1	71	-	77	60	72	73
Oat straw,	1	2	49—51.7 50	50.8—53.2 52	57.2—58 58	35.5—41 38	- -	51.8—54.6 53
Barley hay,	1	4	59	62	62	41	65	63
Hay of Legumes.								
Soy-bean hay,	1	2	61.9—62.7 62	- -	59.5—62.1 61	18.7—39.7 29	70.1—72.1 71	66.1—71.5 69
Peanut-vine hay,	1	2	59.5—60.2 60	- -	51.2—52.6 52	62.1—69.8 66	63—63.6 63	69.3—69.7 70

* Below 10 per cent.

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Hay of Legumes — Concluded.								
Cow-pea-vine hay (fair quality),	1	2	- 59	- -	41.2—44.6 43	46.4—53.7 50	63.9—65.1 65	- 71
Clover hay (late bloom, fair quality),	1	2	54.4—55.5 55	55.9—56.4 56	43.8—49 46	51.8—54.8 53	49.3—59.1 55	63.3—64.8 64
Clover hay (good quality),	1	2	50.8—53.5 52	51.6—54.3 53	46.6—49 48	40—48 43	47—52.2 49	56.8—58.9 58
White clover hay (bloom),	1	1	66	67	61	51	73	70
Scarlet clover hay (*T. incarnatum*),	3	9	56.8—65.4 62	52—58 56	32—58.1 45	29—54 44	64—73 69	52—73.6 62
Alsike clover (*T. hybridum*),	2	3	61.1—64.3 62	62—65.2 63	51—58.7 53	35.1—69.3 50	64—69.2 66	66.5—74.1 71
Alfalfa (lucerne) (late bloom),	1	2		-	49	54	77	64
Alfalfa (lucerne) (stage not given),	1	1	-	-	43	48	69	72
Corn Plant (partially Air Dry).								
Corn stover,	1	4	61.1—62 62	- -	64.8—68.3 67	48.1—55.8 52	49.6—54.8 52	62.5—64.5 64
Corn stover (shredded, fed dry),	1	2	57	-	65	72	38—42 40	56
Corn stover (shredded, fed wet),	1	2	59—62 60	- -	69—70 70	73—76 74	33—39 36	57—61 59

Corn stover (average all tests),	3	8	60	-	67	62	45	61
Corn stover (tops and blades),	1	2	59—60.5 60	- -	71.1—71.7 71	70.6—71.9 71	54.2—56.6 55	61.9—62.6 62
Corn stover (leaves of),	1	2	54.8—56.2 56	- -	54.3—67 61	60.6—65.4 63	43.1—68.8 56	57.1—60.6 59
Corn stalk (below ear),	1	2	64—69 67	- -	71—75 74	79—80 80	15—27 21	65—73 69
Topped stover (part above ear),	1	2	52—58 55	- -	69—72 71	62—65 64	17—27 22	50—57 54
Corn husks,	1	2	71—73 72	- -	78—81 80	23—42 33	24—35 30	75 -
Corn leaves (below ear),	1	2	62—67 65	- -	75—80 78	52—59 56	28—41 35	66—70 68
Flint corn fodder (ears just forming),	1	3	69—72 70	71—73 71	72—73 72	63—71 67	69—73 70	71—73 71
Flint (mature) field corn fodder,	4	9	68—73 71	71—75 73	69—80 76	59—77 70	59—79 65	69—78 73
Dent (mature) field corn fodder,	6	14	57—70 66	- -	43—68 57	64—82 76	30—61 48	61—81 72
Average both kinds,	-	-	68	-	65	74	55	73
Dent (in milk) field corn fodder,	5	11	58.8—66 63	- -	50—71 64	67—79 75	44—51 50	61—69 66
Dent (immature, Burrill and Whitman, coarse),	1	4	51—64 57	- -	45—74 59	66—84 76	20—36 27	57—66 61
Dent (immature, no ears formed),	4	8	61—70 65	63—71 67	63—77 71	59—72 66	57—67 62	57—70 64
Sweet corn fodder (mature),	3	6	60—71 67	62—74 70	70—77 74	63—71 74	54—73 64	57—73 68

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Miscellaneous Dry Substances.								
Hay of wild oat grass (*Danthonica spicata*),	2	3	59.6–68.3 64	61.2–69.1 65	65.1—70.6 68	38.2—62.8 50	48.6—68 58	62.1—68.8 65
Hay of witch grass (*Triticum repens*),	2	4	59.9–62.7 61	61—64.3 62	56.4—67.6 62	53.6—60 57	49.5—64.2 58	62.1—69.9 66
Hay of buttercups (*Ranunculus acris*),	1	2	56	57	41	70	56	67
Hay of white weed (*Leucanthemum vulgare*),	1	2	58	58	46	62	58	67
Cats-tail millet (*Pennesetum spicatum*),	1	2	61.1—63.6 62	- -	64.7—68.4 67	44.7—47.6 46	60.6—64.6 63	58.3—60 59
Johnson-grass hay,	1	1	55	-	58	39	45	54
Sorghum fodder (leaves),	1	2	59.9—66.3 63	- -	64.9—75.9 70	46.3—47.1 47	59.5—62.2 61	62.5—66.6 65
Sorghum bagasse,	1	1	61	-	64	46	14	65
Cotton-seed hulls (fed alone),	4	13	35—47.5 41	- -	.54—57.6 47	58.2—89.3 79	.00—24.6 6	12.9—45.7 34
Cotton-seed hulls when fed with cotton-seed meal (7 to 1 and 6 to 1),	1	3	41 -	- -	33—40 38	- 78	- -	48—50 49
Cotton-seed hulls when fed with cotton-seed meal (4 to 1 to 1½ to 1),	3	11	43—48 45	- -	43—50 46	66—80 76	- -	49—57 51
Cotton-seed feed (hulls and meal, 7 to 1 and 6 to 1),	1	3	45—46 46	- -	34—40 37	81—82 82	44—46 45	50—51 50
Cotton-seed feed (hulls and meal, 4 to 1 to 1½ to 1),	3	11	52—56 55	- -	43—49 46	84—86 85	61—65 62	49—56 54

Green Fodders.								
Dent corn fodder (immature),	4	11	64—74 68	- -	60—76 67	37—83 68	56—80 66	64—79 71
Dent corn fodder (in milk),	3	9	70	-	64	78	61	76
Dent corn fodder (glazing),	5	9	67	-	51	78	54	75
Dent corn fodder (mature),	2	4	65	-	55	73	51	72
Average (glazing and mature),	7	13	66	-	52	76	53	74
Dent corn fodder (ears glazing, Burrill and Whitman, coarse),	1	2	51—54 52	- -	46—47 46	74—82 78	20—28 24	57—61 59
Sweet corn fodder (milk),	1	2	77—78 77	- -	74—76 75	73—74 74	77—78 77	80—81 81
Sweet corn fodder (ears roasting stage), (Storrs),	3	6	- -	67—79 72	54—72 60	76—82 79	52—69 62	73—82 77
Early amber sorghum (just after blossom)	1	2	60.9—61.7 61	- -	41.7—45.3 42	67 -	37.7—42.5 40	70.4—70.8 71
Sorghum in blossom (variety not stated),	1	2	73.1—73.3 73	- -	74—75 75	81.3—81.6 81	51.1—55.7 53	78.2—78 78
Average both samples,	2	4	67	-	59	74	46	74
Green grass (young),	1	1	69	-	74	55	65	72
Same (dry),	1	1	71	-	77	60	71	73
Pasture grass,	1	2	71.9—75.6 74	- -	74.6—76.5 76	74—74.9 74	74—76.5 75	73.8—77.1 75
Average of three samples,	-	-	71	-	76	63	70	73
Rowen grass (mostly Timothy two-thirds grown),	1	2	- -	65—67 66	60—68 64	51—55 52	72—72 72	67—68 68
Barley fodder (bloom),	2	4	- -	62—71 67	49—66 61	56—63 60	69—73 72	69—76 71

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Green Fodders — Concluded.								
Oat fodder (bloom?),	1	2	- -	63—65 64	58—63 60	68—71 70	75—76 75	63—63 63
Rye fodder (formation of head),	1	2	73—74 74	- -	80—80 80	74—74 74	79—80 79	70—71 71
Hungarian grass (early to late bloom),	3	8	61—67 63	61—74 68	65—76 70	48—85 62	59—72 63	64—71 67
Peas and barley (full bloom),	1	2	- -	55—65 60	38—49 43	54—65 60	73—81 77	56—67 61
Peas and oats (bloom?),	1	2	- -	67—69 68	54—61 57	73—74 74	81—82 81	66—67 66
Clover fodder (late blossom),	1	2	65—67 66	- -	52—53 53	63—66 65	66—68 67	76—79 78
Clover rowen (mostly clover late bloom),	1	2	- -	60—62 61	51—54 52	60—61 61	61—62 62	64—68 65
Scarlet clover (late bloom),	1	3	- -	68—70 69	54—58 56	63—69 66	77—77 77	74—75 74
Average three samples,	3	7	-	-	54	64	70	72
Soy-bean fodder (before bloom, August),	1	2	- -	64—67 66	45—55 50	50—58 54	77—80 79	71—73 72
Soy-bean fodder (seed half grown),	1	2	- -	61—63 62	38—43 41	49—59 54	68—71 69	72—75 73
Cow-pea fodder (ready for soiling),	1	2	- -	76—76 76	57—58 57	56—62 59	73—75 74	84—84 84
Canada peas (just before bloom),	1	2	- -	71—72 71	62—62 62	50—55 52	81—83 82	71—71 71

Corn Silage.								
Dent silage (immature),	5	13	60—68 64	- -	71—78 70	64—85 71	42—65 54	60—70 66
Dent silage (milk to mature),	6	17	60-74 64	- -	45—80 62	78—90 85	45—63 52	63—73 69
Dent silage (stage uncertain, North Carolina),	1	4	53—67 60	- -	43—64 56	55—79 70	19—34 24	61—76 68
Flint silage (ears glazing),	4	11	68—78 75	66—80 77	75—79 77	- 82	48—73 65	71—83 79
Fine crushed silage (steers),	1	2	60.4—68 64	- -	72—78 75	75—77 76	32—44 38	60—70 65
Fine crushed silage (sheep),	1	2	51.5—56 54	- -	59.5—67.7 64	67.5—69 68	21—22 21.5	52.6—57.3 55
Corn silage (raw, ears mature),	1	1	-	-	59	86	45	71
Same (cooked),	1	1	-	-	70	87	39	75
Sweet corn ensilage (occasional ears mature),	1	2	66.6—69.6 68	68.5—71.7 70	68.4—73.7 71	82.3—84.6 83	52.7—55.2 54	70.7—73 72
Soy-bean ensilage (goats),	1	2	52—66 59	- -	47—62 55	66—77 72	71—80 76	46—58 52
Soy-bean ensilage (steers),*	1	2	50—50 50	- -	42—44 43	47—52 49	54—56 55	61—61 61
Cow-pea ensilage (steers),	1	4	59—60 60	- -	50—54 52	62—64 63	57—58 57	72—73 72
Barn-yard millet and soy-bean ensilage (sheep),†	1	4	54—65 59	- -	61—73 69	69—75 72	55—62 57	54—63 59
Corn and soy-bean ensilage (sheep),†	1	3	66—72 69	- -	59—73 65	80—84 82	63—67 65	73—78 75

* Must have been very mature as results are exceptionally low. See green soy bean.

† Millet was *P. crus-galli* (Japan). Corn was Pride of the North (medium dent). Soy bean was medium green.

Table of the Digestibility of American Feed Stuffs — Continued.

KIND OF FODDER.	Number of Different Samples.	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
Roots, Tubers, etc.								
Potatoes,	1	3	73.3—80.1 77	74.6—81.2 78	- -	13 -	43.4—45.4 44	87.3—93.4 91
Sugar beets,	1	2	94.2—94.8 95	97.6—99.9 99	88.5—113 100	46.4—53.5 50	90—92.6 91	99.8—100 100
Mangolds,	1	2	77.1—80 79	82.7—87 85	26.8—58.8 43	- -	69.7—79.8 75	90.8—91.9 91
English flat turnips,	1	2	90.7—94.9 93	93.2—99 96	89.2—117 100	82.5—92.5 98	84.5—95 90	96—97 97
Ruta-bagas,	1	2	84.4—90 87	89.2—93 91	61—87.5 74	76.8—91.6 84.2	74.7—85.9 80.3	94.4—95.1 95
Grains and Seeds.								
Corn meal (maize),	2	5	83—98 88	- -	- -	80—98 92	40—77 60	85—100 93
Corn and cob meal,	1	3	74—83 79	- -	2—86 45	82—85 84	43—65 52	86—91 88
Pea meal,	1	2	85—88 87	86—89 88	25—26 26	52—57 55	80—86 83	93—94 94
Raw cotton seed,	1	2	63—69 66	- -	65—86 76	- 87	66—70 68	49—50 50
Roasted cotton seed,	1	2	53—58 56	- -	62—69 66	68—75 72	44—50 47	50—53 51
Soy-bean meal,	2	10	75—82 79*	- 78	- -	81—90 85	- 87	- 73
Cotton seed meal,	2	6	67—82 76	- -	32 -	87—100 93	83—96 88	44—75 64

By products.								
Cleveland linseed meal,	1	3	73—83 80	- -	49—100 74	90—98 93	86—88 85	82—87 84
Old-process linseed meal (National Linseed Oil Company),	1	3	75—82 79	- -	38—71 57	85—92 89	86—93 89	76—79 78
Gluten meal,	1	2	85—90 87	86—92 89	- 33	86—90 88	83—90 87	88—94 91
Chicago gluten meal,	1	2	87—89 88	- -	- -	92—94 93	87—91 89	93—94 93
King gluten meal,	1	2	79—82 81	- -	- -	91—97 94	- 91	78—81 79
Pope cream gluten meal,	1	2	92—95 93	- -	- -	96—99 98	83—84 84	85—91 88
Average all gluten meals,	4	8	87	-	-	93	88	88
Buffalo gluten feed (one lot),	1	2	76—80 78	- -	40—46 43	81—82 81	84—86 85	78—84 81
Buffalo gluten feed (another lot),	1	2	87—88 87	- -	84—94 89	92—95 93	87—87 87	87—87 87
Peoria gluten feed,	1	2	84—87 86	- -	59—97 78	76—82 79	81—85 83	90—90 90
Pope gluten feed,	1	2	86—87 87	- -	76—78 77	79—82 81	85—88 86	90—90 90
Average all gluten feeds,	4	8	84	-	72	83	85	87
Chicago maize feed,	1	2	83—85 84	- -	68—76 72	90—90 90	83—84 84	84—87 85
Atlas gluten meal (feed),	1	2	80—80 80	- -	?- ?-	90—92 91	73—73 73	84—85 84
Winter wheat bran,	1	3	57—66 62	- -	- 27	51—80 64	75—79 77	62—76 65

* For two sheep only.

Table of the Digestibility of American Feed Stuffs — Concluded.

KIND OF FODDER.	Number of Different Samples	Number of Single Trials.	Dry Matter (Per Cent.).	Organic Matter (Per Cent.).	Crude Cellulose (Per Cent.).	Crude Fat (Per Cent.).	Crude Protein (Per Cent.).	Extract Matter (Per Cent.).
By-products — Concluded.								
Spring wheat bran,	1	2	62—63 63	- -	22—25 24	76—76 76	78—82 80	70—71 70
Average all wheat bran,	5	11	61	63	22	68	79	69
Wheat middlings,*	1	2	72.6—72.2 75	75.1—79.3 77	- -	84.1—86.1 85	78.4—79.4 79	80.7—84.5 83
Wheat middlings,*	1	2	79.48—85.63 83	- -	32.57—40.06 36	81.71—87.98 85	81.83—87.75 85	84.43—91.08 88
Rice meal,	1	2	71—76 74	- -	? ?	91—92 91	- 62	89—95 92
Rye meal,	1	2	85—90 87	- -	- -	63—65 64	83—85 84	89—94 92
Peanut feed,	1	2	32—32 32	- -	10—13 12	89—90 90	70—71 71	41—58 49
Malt sprouts,	1	1	67	68	34	100	80	69
Dried brewers' grains,	1	2	62—62 62	- -	50—55 53	89—93 91	78—81 79	59—59 59
Corn cobs,	1	2	59—60 59	- -	65—66 65	44—56 50	13—22 17	60—60 60

II. Experiments with Swine.

Maize kernels (whole),	1	1	83	83	38	46	69	89
Maize meal,	2	2	89.5—89.7 90	91.3—92.1 92	29.4—48.7 39	77.6—81.7 80	86.1—89.9 88	93.9—94.2 94
Maize meal (with cobs),	1	1	76	77	29	82	76	84
Pea meal,	1	1	90	92	78	50	89	95
Barley meal,	1	1	80	80	49	57	81	87
Wheat (whole),	1	2	72	-	30	60	70	74
Wheat (cracked),	1	2	82	-	60	70	80	83
Wheat shorts,	1	2	74—79 77	- -	25—48 37	- -	71—75 73	85.5—88 87
Wheat bran,	1	2	53.7—68.6 61	- -	29.6—39.1 34	65.4—78.1 72	74.4—75.8 75	56—75 66
Potatoes,	1	4	97	-	-	-	84	98

* Probably different products.

LITERATURE.

The following publications have been consulted in compiling the tables of the digestibility of American feed stuffs : —

Reports of Storrs (Connecticut) Experiment Station, 1894, 1895.

Reports of the Maine State Experiment Station for 1886, 1887, 1888, 1889, 1890, 1891, 1893, 1894.

Reports of the New York Experiment Station, 1884, 1888, 1889.

Reports of the Pennsylvania Experiment Station, 1887, 1888, 1889, 1890, 1891, 1892, 1893.

Bulletins Nos. 80 *c*, 81, 87 *d*, 97 and 118 of the North Carolina Experiment Station.

Bulletin No. 16, Utah Experiment Station.

Bulletin No. 3 of the Wisconsin Experiment Station for 1884, and Sixth Annual Report, 1889.

Bulletin No. 8 of the Colorado Experiment Station.

Bulletins Nos. 26 and 36 of the Minnesota Experiment Station.

Bulletin No. 6 of the Oregon Experiment Station.

Bulletins Nos. 13, 15 and 19 of the Texas Experiment Station.

Bulletins Nos. 20 and 41 of the Maryland Experiment Station.

Eleventh and Twelfth Annual Reports (1893 and 1894) of the Massachusetts State Experiment Station.

Report of Hatch Experiment Station, 1895, 1896.

Bulletin No. 43 of the Illinois Experiment Station.

REPORT OF THE CHEMIST.

DEPARTMENT OF FERTILIZERS AND FERTILIZER MATERIALS.

Charles A. Goessmann; Assistants: H. D. Haskins, R. H. Smith

Part I. Field Experiments.

1. Experiments to study the effect of raising leguminous crops in rotation with grain crops on the nitrogen sources of the soil.
2. "Nitragin," a germ fertilizer for the cultivation of leguminous crops.
3. Observations with leguminous crops at Amherst.
4. Mixed annual forage crops *v.* clovers.
5. Experiments to study the economy of using natural phosphates in place of acid phosphates (superphosphates).
6. Experiments to ascertain the influence of different mixtures of chemical fertilizers on the character and yield of garden crops.

Part II. Work in the Chemical Laboratory.

1. Report on inspection of commercial fertilizers.
2. New laws for the regulation of trade in commercial fertilizers.
3. Report on general work in the laboratory.
4. Compilation of analyses of manurial substances, fruits, garden crops and insecticides.

PART I.

REPORT ON FIELD EXPERIMENTS.

CHARLES A. GOESSMANN.

1. FIELD EXPERIMENTS CARRIED ON FOR THE PURPOSE OF STUDYING THE EFFECT OF A LIBERAL INTRODUCTION OF CLOVER-LIKE PLANTS — LEGUMINOUS CROPS — INTO FARM PRACTICE, AS A MEANS OF INCREASING THE RESOURCES OF AVAILABLE NITROGEN PLANT FOOD IN THE SOIL UNDER CULTIVATION FROM THE ELEMENTARY NITROGEN OF THE AIR. (*Field A.*)

The observation of the fact that the different varieties of clover and of clover-like plants in general, as peas, beans, vetches, lupines, etc., are in an exceptional degree qualified, under favorable conditions, to convert, by the aid of certain micro-organisms of the soil, the elementary nitrogen of the air into plant food, imparts to that class of farm crops a special interest from an economical stand-point. This circumstance is in a controlling degree due to the following two causes: —

First. — The nitrogen-containing soil constituents of plant food are, as a rule, in a high degree liable to suffer serious changes in regard to their character and fitness as well as in reference to their quantity.

Second. — Available nitrogen-furnishing manurial substances are the most costly articles of plant food in our markets.

Field experiments which propose to show, by their results, to what extent the cultivation of clover-like plants can be relied on as a practical and economical means for securing efficiently nitrogen plant food for the crops to be raised have

deservedly of late engaged the most careful attention of agricultural investigators.

The systematic treatment of the field here under consideration (Field A), as far as suitable modes of cultivation and of manuring are concerned, was introduced during the season of 1883 to 1884.

The subdivision of the entire area into eleven plats "one-tenth of an acre each," of a uniform size and shape, 132 feet long and 33 feet wide, with an unoccupied and unmanured space of 5 feet in width between adjoining plats, has been retained unaltered since 1884.

A detailed statement of the temporary aim and general management of the experiments, as well as of the results obtained in that connection from year to year, forms a prominent part of my contemporary printed annual reports, to which I have to refer for further details, 1884–96.

Our observations upon Field A are divided into three periods: —

(*a*) Study of the existing soil resources of plant food, 1884 to 1889.

(*b*) Study of the effect of excluding nitrogen plant food from outside sources and of adding nitrogen plant food in various available forms, 1889 to 1892.

(*c*) Studying the effect of the cultivation of leguminous crops on the resources of available nitrogen plant food in the soil under treatment, 1892 to 1897.

The first four years of the stated period 1884 to 1889 were principally devoted to an investigation into the general character and condition of the soil under cultivation as far as its natural and inherent resources of available phosphoric acid, nitrogen and potash were concerned.

The soil proved to be in particular deficient in potash. Different varieties of corn (maize) were raised in succession to assist in the investigation.

Since 1889 the main object of observation upon the same field has been to study the influence of an entire exclusion of any additional nitrogen-containing manurial substance from the soil under cultivation, as well as of a definite additional supply of nitrogen in different forms of combination on the character and yield of the crop selected for the trial.

Several plats (4, 7 and 9) which for five preceding years (1884 to 1889) had not received any nitrogen compound for manurial purposes, were retained in that state, to study the effect of an entire exclusion of nitrogen-containing manurial substances on the crop under cultivation; while the remaining ones received, as before, a definite amount of nitrogen in the same form in which they had received it in preceding years, namely, either as sodium nitrate (1, 2), as ammonium sulphate (5, 6, 8), as organic nitrogenous matter in form of dried blood (3, 10), or of barn-yard manure (0).

A corresponding amount of available nitrogen was applied in all these cases.

1889–94.

Plats.	Annual Supply of Manurial Substances per Plat (1-10 of one Acre).
Plat 0,	800 lbs. of barn-yard manure, 32 lbs. of potash-magnesia sulphate and 18 lbs. of dissolved bone-black.
Plat 1, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 2, .	29 lbs. sodium nitrate (= 4 to 5 lbs. nitrogen), 48 5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 3, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 4, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 5, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 6, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 7, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 8, .	22.5 lbs. ammonium sulphate (= 4 to 5 lbs. nitrogen), 25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 9, .	25 lbs. muriate of potash (= 12 to 13 lbs. potassium oxide) and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).
Plat 10, .	43 lbs. dried blood (= 5 to 6 lbs. nitrogen), 48.5 lbs. potash-magnesia sulphate (= 12 to 13 lbs. potassium oxide), and 50 lbs. dissolved bone-black (= 8.5 lbs. available phosphoric acid).

Amount of Fertilizing Ingredients used annually per Acre.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen, ...	45 pounds.
	Phosphoric acid, . . .	80 pounds.
	Potassium oxide, . . .	125 pounds.
Plats 4, 7, 9, . . .	Nitrogen, ...	none.
	Phosphoric acid, . . .	80 pounds.
	Potassium oxide, . . .	125 pounds.

The mechanical preparation of the soil, the incorporation of the manurial substances, the seeding, cultivating and harvesting, were carried on year after year in a like manner, and as far as practicable on the same day in case of every plat during the same year.

Kind of Crops raised.

Corn (maize), ...	in 1889.
Oats, ...	in 1890.
Rye, ...	in 1891.
Soy bean, ...	in 1892.

The annual yield of the various crops upon the different plats showed, as a rule, that those plats (4, 7, 9) which had not received in any form nitrogen for manurial purposes yielded much smaller crops than those that annually received in some form or other an addition of a corresponding amount of available nitrogen.

The total yield of crops on the plats receiving no nitrogen supply was, during the succeeding years, as follows: —

With corn in 1889, one-fifth less.

With oats in 1890, one-fifth to one-sixth less.

With rye in 1891, one-fifth to one-sixth less.

With soy bean in 1892, one-third to one-fourth less.

The results of four years (1889 to 1892) of observations were expressed in the following conclusions: —

The experiments carried on upon Field A during the years 1889, 1890, 1891 and 1892 show conclusively the importance of a liberal supply to the soil of an available form of nitrogen to secure a successful and remunerative cultivation of farm crops under otherwise corresponding favorable conditions. For even a leguminous crop, the soy bean, when for the first time raised upon Field A, did not furnish an exception to our observation (1892). (For details, see report for 1892.)

1893–97. — Subsequent to the year 1892, when for the first time in the more recent history of the field under discussion an *annual leguminous crop*, a late-maturing variety of soy bean, had been raised upon it, it seemed of interest to ascertain whether the raising of *the soy bean* upon Field A had increased the amount of available nitrogen stored up in

the soil to such an extent as to affect the yield of succeeding crops upon those plats (4, 7, 9) which, as a rule, had not received at any time for eight successive years an addition of available nitrogen from any other manurial source but the atmospheric air and the roots left in the soil after harvesting the crops raised.

A grain crop (oats) was selected as the crop suitable to serve for that purpose. The general management of the experiment, as far as the preparation of the soil, manuring and seeding-down are concerned, was the same as in previous years (see tenth annual report).

An examination of the yield of the crop in 1893, secured upon the different plats, showed that the total crop per acre on those plats to which no nitrogen was applied (4, 7, 9) averaged 800 pounds less than in case of the plats which received their regular supply of nitrogen in some form or other. The average yield of oats upon the plats (4, 7, 9) which had received no nitrogen supply from any outside source was *from one-seventh to one-eighth less in weight* than the average yield of the remaining plats, which received annually additional nitrogen supply.

From these results it appeared that the introduction of an annual leguminous crop into our rotation had somewhat reduced the difference in yield between the plats receiving no nitrogen and those receiving it, yet had not entirely obliterated it. It was decided to continue the observation by repeating the raising of soy beans in 1894, oats in 1895 and soy beans in 1896.

1894. — To secure, if possible, more decisive results regarding the presence and absence of available nitrogen, it was decided to use twice the amount of phosphoric acid and potassium oxide, as compared with the preceding years.

Amount of Fertilizing Ingredients applied per Acre during 1894.

Plats 0, 1, 2, 3, 5, 6, 8, 10,	Nitrogen,	45 pounds.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.
Plats 4, 7, 9,	Nitrogen,	none.
	Phosphoric acid,	160 pounds.
	Potassium oxide,	250 pounds.

An early-maturing variety of soy bean was selected for the experiments. The fertilizer mixtures were applied as in previous years, broadcast, in the middle of April. Owing to the protracted drought of July and August the crop did not get that fulness of growth which might have been obtained under more favorable conditions. The crop was cut August 28.

The difference in the average yield of crop between the plats (4, 7, 9) which thus far had received no available nitrogen from outside manurial sources, as compared with that from those which had received it in some form or other, was more marked than in previous years. It amounted to one-third in favor of the latter.

1895. — In 1895 oats were again selected, as stated above, to succeed soy bean, for the reason of permitting a direct comparison of the results of 1892 (soy bean) and 1893 (oats) with those of 1894 (soy bean) and 1895 (oats).

The ploughing, manuring, seeding down, etc., was carried out in the same manner as during the preceding season (1894).

The average yield of the plats with and without nitrogen supply from outside sources showed that no material change in their relative degree of productiveness had taken place.

1896. — It was decided to substitute in our experiment a perennial leguminous plant, medium red clover, for the annual leguminous plant, the soy bean, to ascertain whether more satisfactory results will be secured from that change.

As a few years' observation are required to obtain a satisfactory basis for reliable conclusions, reports are deferred.

2. Experiments with "Nitragin," a Germ Fertilizer for the Cultivation of Clover and Clover-like Plants — Leguminous Crops.

The history of progress in agriculture shows that a more general and liberal introduction of clover and clover-like plants, as beans, peas, vetches, etc., as forage crops, into a general system of farm management has everywhere increased the chances of a more remunerative farming. The valuable investigations of Laws and Gilbert have furnished striking

proofs of the special claims of these crops as nitrogen gatherers when compared in that direction with grain crops.

The subsequent important discovery of the real cause of the exceptional behavior of these crops by Hellriegel and others has given not only a satisfactory explanation of previous observations in practical agriculture but has also imparted, for economical reasons, an increased interest in the study of successful methods of raising clovers, etc., without the aid of a liberal supply of nitrogen-containing manurial substances.

Hellriegel and his co-laborers established by careful observation the fact that leguminous plants, like clovers, beans, vetches, lupines, etc., with the assistance of certain micro-organisms (root bacterium) found in the soil, can utilize the elementary nitrogen of the air for the formation of nitrogen plant food fit for the support of their growth.

These micro-organisms fasten themselves upon the roots of the clover, etc., penetrate the epidermis and form in the course of their growth swellings, nodules or tubercles, of varying size and shape. Their presence and growth in the tissue of the roots of this stated class of plants is considered an essential condition for the conversion of the elementary nitrogen of the air into suitable nitrogen plant food. The recognition of the circumstance that their presence or absence in the soil controls the results in a material degree, even under otherwise favorable conditions, has turned the attention of progressive agriculturists towards the study of the circumstances which secure success.

Quite prominent among the more recent results of investigation in this direction are the observations that a variety of root bacterium exists ; that some infest the roots of one kind of leguminous plant while others thrive upon other kinds : that is to say, some leguminous crops may fail to give satisfactory returns where others prosper on account of the presence or absence of the right variety of root bacterium, or of suitable condition of the soil for their vigorous development.

These results caused the introduction of various modes of infecting the soil, wherever found necessary, with the desired kind of bacterium germ, before seeding down the new crop. A very common method consisted in scattering a

certain amount of soil, taken from a field where the crop to be raised has been successfully grown, over the surface of the new land before ploughing it. This method has been successfully practised by us on various occasions. Another is to abstract with water some of the soil, which from previous observation is known to contain the desired root bacterium germs, and sprinkle the watery extract over the soil before ploughing.

One of the latest developments in this direction is the appearance in the general market of patented germ fertilizer for leguminous crops. Considering the whole subject from a practical stand-point of sufficient interest, I insert below a copy of a circular received at this office. The connection of two German investigators of excellent reputation with the enterprise invites attention.

Three different kinds of germ fertilizers, for medium red clover, for crimson clover and for sweet or Bokhara clover, have been imported during the past season and are on trial upon the grounds of the station.

Nitragin.

Germ Fertilizers for Leguminous Crops.

(Prepared according to Drs. Nobbe and Hiltner.)

The principal food materials abstracted from the soil by plants, and which therefore require to be replaced in the form of manures, are potash, phosphoric acid, lime and nitrogen.

Respecting the last it has been known that leguminous crops, such as clover, vetches, peas, beans, lupines, etc., do not usually require to be manured with nitrogen (in form of nitre or ammoniacal compounds), and yet under favorable conditions yield rich harvests, whilst the soil is even enriched with nitrogen.

The reason of this peculiar behavior for many years remained unexplained, but the onward march of modern science has now demonstrated the ability of leguminous plants to abstract nitrogen from the air, only, however, by the aid of a specific kind of micro-organism, a bacterium that resides in the characteristic nodules on the roots. If these bacteria are not at the disposal of the plant then it looses its ability to utilize the atmospheric nitrogen, and hence it is found that not every leguminous plant is able to flourish luxuriantly without nitrogenous manure; many remain small and stunted under conditions otherwise favorable, and evidently suffer from the lack of nitrogen.

It is therefore a matter of extreme importance to the farmer to make certain that each field of legumes is supplied with the necessary quantum of bacteria; only then can he expect to obtain full crops from poor sandy soils without nitrogen manures (*i. e., without saltpetre, ammonia, etc.*), *and only then will he reap the advantage of a soil enormously enriched with nitrogen.*

The wide bearing of this newly discovered principle has already been taken into practical consideration, and fields are now inoculated, that is to say, strewn with earth in which legumes have already flourished. This method, however, apart from its great cost and the loss of time and labor entailed, also involves the danger of disseminating injurious as well as useful bacteria.

This disadvantage is, however, now completely overcome by the pure patent germ fertilizer Nitragin, which consists of a pure cultivation of the specific bacteria of legume nodules in a suitable medium.

The inoculation of the seed or of the soil with the germ fertilizer, according to the directions given below, possesses the following advantages: —

1. Every single seed is surrounded with bacteria which, after germination, penetrate the root hairs and commence their role as collectors of nitrogen, so that a good crop is secured in the poorest soil without nitrogenous manures.

2. Through the storage of nitrogen by the bacteria, the soil itself becomes richer in nitrogen in an assimilable state, to the advantage of the other crops grown in rotation.

3. The disadvantages of the mode of inoculation previously adopted are avoided.

4. Manuring with nitrogen in the form of saltpetre, ammonium salts, etc., is absolutely unnecessary.

Directions for Use.

Every bottle contains sufficient for inoculation of $2\frac{1}{2}$ roods.

If the contents of the bottle have already become liquid, they are used as described below for the direct inoculation of the seed. If solid, the contents can be easily liquefied by warming the bottle gently for a few minutes, for instance, in the trousers' pocket, in tepid water or in a warm room. *Exposure to temperature above the heat of the body, which is amply sufficient to melt, or to direct sunlight must under all circumstances be strictly avoided.*

The liquid contents are poured into a vessel containing one to three pints of clean water (carefully washing out the whole contents of the bottle with a little water), and then shaken or stirred

until the fertilizer is equally distributed throughout the vessel and the bacteria are well mixed in the water.

The inoculated water thus prepared is poured over the seed and worked with the hands (or the shovel) until every seed has been moistened. If the quantity of water is insufficient more must be added, but usually for small seed a pint and a half will suffice and for large seeds two to three quarts. The moistened seed is then reduced to a condition suitable for sowing by mixing with some dry sand or fine earth and if necessary allowing it to stand, turning it over from time to time; too great dryness is deleterious. The sowing and turning in is carried out in the manner usually practised. If possible, however, avoid sowing in glaring sunlight.

Instead of inoculating the seed, the same and, in some cases, better results are obtained by inoculating the soil by means of inoculated earth. For this purpose for every 2½ roods one-half a hundred weight of earth is inoculated in the above-described manner, using a proportionately larger quantity of water; the inoculated earth is then dried in the air or mixed with dried earth, scattered equally over the field, and worked in three or four inches deep.

For larger surfaces than 2½ roods a corresponding number of bottles must be used (8 bottles to 5 acres).

As the bacteria are absolutely innocuous, there is no fear of danger from the bottles being left about or employed for other purposes.

Attention is specially directed to the fact that the "germ fertilizers" should only be used for the species of Leguminosæ marked on the label of the bottle. For greater distinction the bottles bear differently colored labels.

Manufactured by the Farbwerke vorm. Meister Lucius & Bruning, Hoechst on Main, Germany.

Specification of the Various Kinds of "Nitragin" (registered) Germ Fertilizers for Leguminous Crops.

Common pea (*Pisum sativum*), red label.
Sand pea (*Pisum arvense*), red label.
Common vetch (*Vicia sativa*), blue label.
Hairy vetch (*Vicia villosa*), blue label.
Common field bean or horse bean (*Vicia faba*), blue label.
White lupine (*Lupinus albus*), green label.
Yellow lupine (*Lupinus luteus*), green label.
Blue lupine (*Lupinus angustifolus*), green label.
Clover, red (*Trifolium pratense*), label gold on green.
White clover or Dutch clover (*Trifolium repens*), label gold on green.

Alsike clover (*Trifolium hybridum*), label gold on green.
Carnation clover or trifolium (*Trifolium incarnatum*), label gold on green.
Bokhara clover (*Melilotus alba*), label gold on green
Black medick (*Medicago lupulina*), label gold on white.
Lucerne (alfalfa) (*Medicago sativa*), label gold on white.
Kidney vetch (*Anthyllis vulneraria*), label gold on white.
Sainfoin (*Onobrychis sativa*), gold label on violet.
Serradella (*Ornithopus sativus*), label gold on pink.
Wild everlasting pea (*Lathyrus sylvestris*), label gold on blue.

When giving your esteemed orders for Nitragin we shall thank you to state always, for what kind of leguminous crops you wish to receive the germ fertilizers.

Yours respectfully,
FARBWERKE VORM. MEISTER LUCIUS & BRUNING.

3. OBSERVATIONS WITH LEGUMINOUS CROPS AT AMHERST.

The cultivation of leguminous crops has for years received special attention at our hands. The majority of reputed leguminous forage crops congenial to our climate have been raised repeatedly and on a sufficiently large scale in most instances to form a fair opinion regarding their merits as forage crops in our section of the country.

The following statement contains the kinds of leguminous crops experimented with at Amherst: —

Medium red clover (*Trifolium medium*).
Alsike clover (*Trifolium hybridum*).
Crimson clover (*Trifolium incarnatum*).
Japanese clover (*Lespedeza striata*).
Bokhara clover (sweet clover) (*Melilotus alba*).
Serradella (*Ornithopus sativus*).
Sainfoin (*Onobrychis sativa*).
Alfalfa (*Medicago sativa.*)
Scotch tares.
Lentil (*Ervum lens*).
Summer vetch (*Vicia sativa*).
Kidney vetch (*Anthyllis vulneraria*).
Horse bean (*Vicia faba*).
Early-maturing soy bean (*Soja hispida*).
Late-maturing soy bean (*Soja hispida*).
Peas (*Pisum sativum*).
Cow pea (*Dolichos sinensis*).
Flat pea (*Lathyrus sylvestris*).
White lupine (*Lupinus albus*).
Yellow lupine (*Lupinus luteus*).
Blue lupine (*Lupinus perennis*).

For details I have to refer to previous annual reports.

The following local observations are worth mentioning again on this occasion : —

(*a*) Alfalfa (*Medicago sativa*) and crimson clover (*Trifolium incarnatum*), in repeated trials, suffered seriously from winter-killing. This result has to be ascribed more to late frosts early in spring, when the ground is filled with water, than to the severity of mid-winter.

(*b*) Mixed crops of peas, vetch and horse bean, and vetch and oats or barley have given, as a rule, very satisfactory returns as far as quality and quantity are concerned.

(*c*) Soy beans, early and late varieties, have yielded, as a rule, during average seasons large crops; yet they have failed to enrich the soil they were raised upon sufficiently in available nitrogen plant food to secure under otherwise corresponding conditions, as far as the supply of available potash and phosphoric acid is concerned, as high a yield of a succeeding crop of rye, oats, barley and even soy bean, as where from forty to fifty pounds per acre of an available form of nitrogen were added. The liberal addition of nitrates to the soil interfered with a liberal development of root tubercles, in case of soy bean, in a well-infected soil.

Similar results are reported by other investigators in regard to lupines followed by oats or potatoes; an addition of nitrates in connection with a potash and phosphoric acid containing fertilizer increased the yield. The infection of the soil by lupine bacterium did not benefit the growth of other leguminous crops.

The belief that each variety of leguminous crop is associated with a root bacterium of its own finds support in the circumstance that the root tubercles of different varieties of these crops quite frequently vary, not only in size and shape but in their mode of distribution over the main roots or rootlets. Illustrations of this feature have been furnished by the writer in form of photographs from nature in case of soy bean, horse bean, lupines, etc., (see State station report for 1894).

Much has been learned regarding the symbiotic or combined life of root bacteria and leguminous plants, yet much further investigation in the vegetation house and the field

is evidently needed *to secure to the full extent* and with certainty the economical advantages to be derived from the raising of crops which are capable of converting, without expense, the elementary nitrogen of the air into available nitrogen plant food.

Our attention, as will be seen from preceding statements, has been of late directed to the question *whether perennial leguminous crops, as our current varieties of clovers*, may prove more satisfactory as nitrogen gatherers for general farm purposes than annual leguminous crops, as soy bean, lupines, etc.

4. Mixed Annual Forage Crops v. Clovers (*Field B*).

The importance of a more liberal and economical supply of nutritious forage crops for the support of farm live stock is quite generally recognized by all parties interested.

Mixed forage crops, consisting of early-maturing annual leguminous crops, clover-like plants and of either oats or barley, suggested themselves for trial; for they attain in our locality a high feeding value at a comparatively early period of the season, — towards the end of June when in bloom; they can serve with benefit in form of green fodder, hay or ensilage, as circumstances advise; they yield under fair conditions large quantities of fodder of a highly nutritious character, and permit a timely reseeding and maturing of a second crop upon the same lands.

The fields used for our earlier observations, in 1893–94, were located in different parts of the farm. They were, as a rule, in a fair state of cultivation, as far as the mechanical condition of the soil as well as its store of plant food was concerned. The soil consisted in the majority of cases of a somewhat gravelly loam (see reports for 1893–94).

The field used in the experiments, subsequently described somewhat in detail, consisted of a light loam and was divided into eleven plats of corresponding shape with four feet of unoccupied space between them. It was used for the cultivation of potatoes in preceding years. The plats had received on that occasion in all cases the same amount and form of nitrogen and phosphoric acid, in form of ground bones, while the potash supply consisted in alternating

order of plats either of muriate of potash or of high-grade sulphate of potash, containing the same amount of potassium oxide in every case (400 pounds of muriate of potash, 80 to 82 per cent., or of high-grade sulphate of potash, 95 per cent., and 600 pounds of fine-ground bones per acre). This system of manuring the plats has been followed ever since 1893. The same crops have been raised each season upon adjoining plats to notice the particular effect of both forms of potash on the crop raised (for details see previous reports).

Vetch and Oats and Vetch and Barley.

1894. — The same amount and kind of manure were applied for raising vetch and oats and vetch and barley. The field occupied by these crops was ploughed, manured, harrowed and seeded down, as far as practicable, at the same time. The seed was sown in all cases April 26. Four bushels of oats with 45 pounds of vetch were sown, as on previous occasions, while 3 bushels of barley were used with 45 pounds of vetch per acre in case of barley and vetch. Both crops came up May 4 and were of a uniformly healthy condition during their subsequent growth. The barley began to head out June 20; the vetch was at that time beginning to bloom. The crop was cut for hay June 23.

It needs no further statement to understand that the quality of the seeds and of the soil ought to be considered in deciding about weights of the former. Close cultivation is desirable in case of this class of forage crops, for it favors a succulent, tender structure and keeps weeds out.

Average Yield of Crops.

Yield of Barley and Vetch per Acre.

In case of muriate of potash and bone, . .	5,737 pounds of hay.
In case of sulphate of potash and bone, . .	5,077 pounds of hay.

The oats headed out June 25; the vetch was fairly in bloom at this time. The crop was cut for hay July 2.

Yield of Oats and Vetch per Acre.

In case of muriate of potash and bone, . .	8,051 pounds of hay.
In case of sulphate of potash and bone, . .	7,088 pounds of hay.

1895. — During that year the observations of the preceding year were repeated and in some directions enlarged; oats, vetch and horse bean, and oats and lentils were added to those of the preceding year. The same kind and quantity of manures were applied. The field was ploughed April 25 and the manure harrowed in May 3; the seed was sown broadcast May 9. All parts of the field were treated alike, and as far as practicable on the same day. The plats occupied by the crops were in all cases 33 feet wide, with 4 feet unoccupied space between them, and from 191 to 241 feet long. The yield of areas 175 feet long and 33 feet wide, running along by the side of each other, served as our basis for comparing results (5,775 square feet) (for details see report for 1895).

Yield of Vetch and Oats per Acre.

In case of muriate of potash and bone, ...	7,238 pounds.
In case of sulphate of potash and bone, ...	6,635 pounds

Yield of Vetch, Horse Bean and Oats per Acre.

In case of muriate of potash and bone, ...	7,398 pounds
In case of sulphate of potash and bone, ...	5,881 pounds.

Yield of Oats and Lentils per Acre.

The experiment was confined to a trial with sulphate of potash and bone as manure on account of want of a suitable field. The yield was 5,881 pounds of hay.

After the crops stated had been harvested, during the middle of July, in the form of hay, the field was ploughed and prepared for the cultivation of a variety of clovers, mammoth red clover, medium red clover, alsike or Swedish clover, crimson clover and sweet or Bokhara clover, to compare the crops resulting during two succeeding years with those obtained in case of mixed crops of vetch and oats, etc.

The subdivision of the field into eleven plats was the same as in the preceding year; each plat received the same kind and amount of fertilizer as before; the mechanical preparation of the soil was in all cases the same. The seeding down of the different plats took place on the same day, July 23, 1895.

Plats 11 and 12 were each seeded down with 3 pounds of sweet clover seed.

Plats 13 and 14 were each seeded down with 3 pounds of mammoth red clover seed.

Plats 15 and 16 were each seeded down with 3 pounds of medium red clover seed.

Plats 17 and 18 were each seeded down with 2½ pounds of alsike or Swedish clover seed.

Plats 19 and 20 were each seeded down with 4 pounds of crimson or scarlet clover.

Plats 11, 13, 15, 17 and 19 received their potash in form of muriate of potash (80 to 82 per cent.); plats 12, 14, 16, 18 and 20 in form of high-grade sulphate of potash (95 per cent.).

Subsequent History of Crops on Different Plats.

Plats 11 and 12. — The frost affected the crop somewhat by heaving of the soil; the growth was thin and of a light color except in some instances where a deep color and large growth was noticed. A subsequent examination showed in these cases an exceptional development of tubercles on the roots. The crop was harvested June 19.

Plat 11. — Crop weighed green 200 pounds.

Plat 12. — Crop weighed green 285 pounds.

On account of unsatisfactory condition of the plats both were ploughed July 15 and reseeded on July 30, 1896, with 10 pounds of sweet clover seed each, to notice whether a more liberal infection of the soil with suitable bacterium thus secured would result in better and larger returns. Nov. 1, 1896, the crop was looking well and was one foot in height. The dark spots of growth had spread greatly.

Plats 13 and 14. — The crops upon these plats looked well in the fall and during the succeeding spring. The crop was cut before it had reached full bloom, June 23, on account of its being badly lodged; they were harvested as hay June 29.

Total Yield of Hay.

PLATS.	Yield of Hay (Pounds).	Yield of Rowen (Pounds).	Total Yield of Dry Matter (Pounds).
13, ...	615	295	756.65
14, ...	650	305	796.32

The sod looked well on both plats Nov. 1, 1896.

Plats 15 and 16. — The crop looked healthy in the fall and in the succeeding spring; the crop was cut when in full bloom, June 19, and harvested June 23. The rowen was cut July 28 and harvested July 30. A third crop was cut October 9 and harvested October 26.

Total Yield of Hay.

PLATS.	Yield of Hay (Pounds).	Yield of Second Crop (Pounds).	Yield of Third Crop (Pounds).	Total Yield of Dry Matter (Pounds).
15, ...	455	276	120	686.62
16, ...	455	294	120	720.55

The sod looked to be in good condition on both plats Nov. 1, 1896.

Plats 17 and 18. — The crop looked well from the beginning and was in bloom June 7. The hay was cut and harvested June 19 and 23.

Total Yield of Hay.

PLATS.	Yield of Hay (Pounds).	Yield of Rowen (Pounds).	Total Yield of Dry Matter (Pounds).
17, ...	620	325	733.21
18, ...	455	200	518.56

Nov. 1, 1896, the sod looked exhausted and was covered with weeds and sorrel.

Plats 19 and 20. — These plats looked well in early winter but almost every plant died out in early spring. The plats were reseeded during the month of April, 1896, with 5½ pounds of seed on each plat. The hay was cut when in bloom July 17 and harvested July 23. The crop was in poor condition when cut and never sprouted again.

Total Yield of Hay.

PLATS.	Yield of Hay (Pounds).	Total Yield of Dry Matter (Pounds).
19, ...	575	422.91
20, ...	595	406.94

Summary of Yield of Crops in 1896 (Dry Matter).

[Pounds.]

PLATS.	Hay.	Rowen.	Total Yield of Dry Matter.
11, ...	–	–	–
12, ...	–	–	–
13, ...	511.62	245.03	756.65
14, ...	541.58	254.74	796.32
15, ...	373.46	313.16	686.62
16, ...	390.12	330.43	720.55
17, ...	458.49	274.72	733.21
18, ...	356.54	162.02	518.56
19, ...	422.91	–	422.91
20, ...	406.94	–	406.94

5. Field Experiments with Different Commercial Phosphates, to study the Economy of using the Cheaper Natural Phosphates or the More Costly Acidulated Phosphates. (*Field F.*)

The field selected for this purpose is 300 feet long and 137 feet wide, running on a level from east to west. Previous to 1887 it was used as a meadow, which was well worn out at that time, yielding but a scanty crop of English hay. During the autumn of 1887 the sod was turned under and left in that state over winter. It was decided to prepare the field for special experiments with phosphoric acid by systematic exhaustion of its inherent resources of plant food. For this reason no manurial matter of any description was applied during the years 1887, 1888 and 1889.

The soil, a fair sandy loam, was carefully prepared every year by ploughing during the fall and in the spring, to improve its mechanical condition; during the same period a crop was raised every year. These crops were selected, as far as practicable, with the view to exhaust the supply of phosphoric acid in particular. Corn, Hungarian grass and leguminous crops (cow pea, vetch and serradella) followed each other in the order stated.

In 1890 the field was subdivided into five plats, running from east to west, each 21 feet wide with a space of 8 feet between adjoining plats. The manurial material applied to each of these five plats contained, in every instance, the same form and the same quantity of potassium oxide and nitrogen, while the phosphoric acid was furnished in each case in the form of a different commercial phosphoric-acid-containing article, namely, phosphatic slag, Mona guano, Florida phosphate, South Carolina phosphate, floats and dissolved boneblack. The market cost of each of these articles in 1890 controlled the quantity applied, for each plat received the same money value of its particular kind of phosphate. The phosphatic slag, Mona guano, South Carolina phosphate, floats and Florida phosphate were applied at the rate of 850 pounds per acre, dissolved bone-black at the rate of 500 pounds per acre. Nitrate of soda was applied at the rate of 250 pounds per acre and potash-magnesia sulphate at the

rate of 390 pounds per acre. (For the analysis of phosphates and cost of each in 1890 see report for 1895.)

The following fertilizer mixtures have been applied annually, from 1890 to 1894, to all plats, with the exception of Plat 3, which received in 1890 ground apatite and in 1891 no phosphate whatever, on account of the failure of securing in time apatite suitable for the trial.

Plats.	Annual Supply of Manurial Substances.	Pounds.
Plat 1 (south, 6,494 square feet),	Ground phosphatic slag, .	127
	Nitrate of soda, . . .	43
	Potash-magnesia sulphate, .	58
Plat 2 (6,565 square feet), .	Ground Mona guano, . .	128
	Nitrate of soda, . . .	43½
	Potash-magnesia sulphate, .	59
Plat 3 (6,636 square feet), .	Ground Florida phosphate, .	129
	Nitrate of soda, . . .	44
	Potash-magnesia sulphate, .	59
Plat 4 (6,707 square feet), .	South Carolina phosphate, .	131
	Nitrate of soda, . . .	44½
	Potash-magnesia sulphate, .	60
Plat 5 (6,778 square feet), .	Dissolved bone-black, . .	78
	Nitrate of soda, . . .	45
	Potash-magnesia sulphate, .	61

Names of Crops raised from 1890 to 1894.

1890, potatoes (see eighth annual report of Massachusetts State station); 1891, winter wheat (see ninth annual report of Massachusetts State station); 1892, serradella (see tenth annual report of Massachusetts State station); 1893, Dent corn, Pride of the North (see eleventh annual report of Massachusetts State station).

Summary of Yield of Crops (Pounds).

PLATS.	1890. Potatoes.	1891. Wheat.	1892. Serradella.	1893. Corn.
Plat 1, phosphatic slag, ...	1,600	380	4,070	1,660
Plat 2, Mona guano, ...	1,415	340	3,410	1,381
Plat 3, Florida phosphate, ...	1,500	215	2,750	1,347
Plat 4, South Carolina floats, ...	1,830	380	3,110	1,469
Plat 5, dissolved bone-black, ...	2,120	405	2,920	1,322

Having for four years (1890–94) in succession pursued the above-stated system of manuring each plat with a differ-

ent kind of phosphate, yet of corresponding money value, it was decided to continue the experiments for the purpose of studying the *after-effect* of the different phosphates on the crops to be raised. To gain this end the phosphates were hereafter in all cases entirely excluded from the fertilizers applied; in addition to this change, the former amount of potash and nitrogen was increased one-half in quantity, to favor the highest effect of the stored-up phosphoric acid in the soil under treatment.

The fertilizers hereafter used had the following composition: —

Plat 1 (6,494 square feet),	64½ pounds of nitrate of soda. 87 pounds of potash-magnesia sulphate.
Plat 2 (6,565 square feet),	65¼ pounds of nitrate of soda. 88 pounds of potash-magnesia sulphate.
Plat 3 (6,636 square feet),	66 pounds of nitrate of soda. 89 pounds of potash-magnesia sulphate.
Plat 4 (6,707 square feet),	66¾ pounds of nitrate of soda. 90 pounds of potash-magnesia sulphate.
Plat 5 (6,778 square feet),	67½ pounds of nitrate of soda. 90½ pounds of potash-magnesia sulphate.

The results of three years (1894 to 1896) are as follows: —

Barley.

Yield of Crop (1894).

Plats.	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds)	Percentage of Grain.	Percentage of Straw.
Plat 1,	490	169	221	34.49	65.51
Plat 2,	405	148	251	34.07	65.93
Plat 3,	290	78	212	26.89	73.11
Plat 4,	460	144	216	31.30	68.70
Plat 5,	390	118	272	30.26	69.74

Rye.

Yield of Crop (1895).

Plats.	Grain and Straw (Pounds).	Grain (Pounds).	Straw and Chaff (Pounds).	Percentage of Grain.	Percentage of Straw.
Plat 1,	695	195	500	28.06	71.94
Plat 2,	631	166	465	26.31	73.69
Plat 3,	383	143	240	37.34	62.66
Plat 4,	759	189	570	24.90	75.10
Plat 5,	625	185	440	29.60	70.40

Medium Green Soy Bean.

Yield of Crop (1896).

Plats.	Whole Crop (Pounds).	Beans (Pounds).	Straw, etc. (Pounds).	Percentage of Beans.	Percentage of Straw, etc.
Plat 1, ...	680	254	426	37.20	62.80
Plat 2, ...	773	233	540	30.14	69.86
Plat 3, ...	717	262	455	36.54	63.46
Plat 4, ...	752	252	500	33.51	66.49
Plat 5, ...	742	247	495	31.94	68.06

Summary of Yield of Crops (1890 to 1896).

[Pounds.]

Plats.	1890. Potatoes.	1891. Wheat.	1892. Serradella.	1893. Corn.	1894. Barley.	1895. Rye.	1896. Soy Bean.
Plat 1, phosphatic slag,	1,600	380	4,070	1,660	490	695	254
Plat 2, Mona guano, .	1,415	340	3,410	1,381	405	630	233
Plat 3, Florida phosphate.	1,500	215	2,750	1,347	290	383	262
Plat 4, South Carolina phosphate (floats).	1,830	380	3,110	1,469	460	759	252
Plat 5, dissolved bone-black.	2,120	405	2,920	1,322	390	625	247

Conclusions.

From the previous statement of comparative yields for average successive years we find that the plat receiving dissolved bone-black leads in yield during the first two years while the third, fourth, fifth and sixth years the plats receiving phosphates insoluble in water are ahead, phosphatic slag being first, with South Carolina floats second.

The following statement regarding the phosphoric acid applied in the case of each plat, and also the amount removed from them by the crops raised, shows approximately how much the former is still stored up in the soil in each plat, not considering the original inherent amount in the soil at the beginning of the trial: —

Phosphoric Acid applied to and removed from Field (Pounds).

PLATS.	1890. Potatoes.		1891. Wheat.		1892. Serradella.		1893. Corn.		Total Amount added.	Total Amount removed.	Total Amount remaining.
	Added.	Removed.	Added.	Removed.	Added.	Removed.	Added.	Removed.			
Plat 1, .	24.18	2.56	24.18	1.23	24.18	8.95	24.18	7.20	96.72	19.94	77.78
Plat 2, .	28.01	2.36	28.01	1.19	28.01	7.50	28.01	6.33	72.04	17.38	54.66
Plat 3, .	109.68	2.40	–	.69	28.01	6.05	28.01	5.95	165.70	15.09	150.61
Plat 4, .	36.12	2.93	36.12	1.31	36.12	6.84	36.12	6.68	144.48	18.12	126.36
Plat 5, .	12.34	3.39	12.34	1.22	12.34	6.42	12.34	6.05	49.36	17.08	32.28

Phosphoric Acid applied to and removed from Field (Pounds) — Concluded.

PLATS.	1894. Barley.		1895. Rye.		1896. Soy Bean.		Total Amount added.	Total Amount removed.	Total Amount remaining.
	Added.	Removed.	Added.	Removed.	Added.	Removed.			
Plat 1, . . .	–	1.92	–	3.41	–	5.84	96.72	31.11	65.61
Plat 2, . . .	–	1.64	–	3.04	–	5.75	72.04	27.81	44.23
Plat 3, . . .	–	.76	–	2.06	–	6.07	165.70	23.98	141.72
Plat 4, . . .	–	1.72	–	3.61	–	6.01	144.48	29.46	115.02
Plat 5, . . .	–	1.49	–	3.11	–	5.89	49.36	27.57	21.79

The experiment needs continuation to secure more decisive results.

6. Field Experiments to ascertain the Influence of Different Mixtures of Commercial Fertilizers on the Yield and General Character of Several Prominent Garden Crops.

The area devoted to the above-stated experiment is 198 feet long and 183 feet wide; it is subdivided into six plats of uniform size (89½ by 62 feet, or about one-eighth of an acre each). The plats are separated from each other and from the adjoining cultivated fields by a space of 5 feet of unmanured and unseeded yet cultivated land.

They are arranged in two parallel rows, running from east to west. Plats Nos. 1, 2 and 3 are along the north side of the field, beginning with No. 1 at its west end, while plats Nos. 4, 5 and 6 are located along its south side, beginning with Plat 4 on the west end. The soil is several feet deep, and consists of a light, somewhat gravelly loam, and was in a fair state of productiveness when assigned for the experiment here under consideration. The entire field occupied by the experiment is nearly on a level. Potatoes and a variety of forage crops have been raised upon it in preceding years. The manure applied since 1885 has consisted exclusively of fine-ground bone and muriate of potash, annually, 600 pounds of the former and 200 pounds of the latter per acre.

The observation with raising garden crops by aid of the different mixtures of commercial manurial substances, here under special consideration, began upon plats Nos. 4, 5 and 6 during the spring of 1891, and upon plats Nos. 1, 2 and 3 during that of 1892.

The difference of the fertilizers applied consisted in the circumstance that the different forms of nitrogen and potash were used for their preparation. All plats received essentially the same quantity of nitrogen, potash and phosphoric acid, and every one of them received its phosphoric acid in the same form, namely, dissolved bone-black. Some plats received their nitrogen supply in form of organic animal matter, dried blood; others in form of sodium nitrate, Chili saltpetre; others in the form of ammonium sulphate. Some plats received their potash in the form of muriate of potash

(plats 1, 2, 3), and others (plats 4, 5, 6) in the form of the highest grade of potassium sulphate (95 per cent.). The subsequent tabular statement shows the quantities of manurial substances applied to the different plats: —

Plats.	Annual Supply of Manurial Substances.	Pounds.
Plat 1,	Sulphate of ammonia,	38
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 2,	Nitrate of soda,	47
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 3,	Dried blood,	75
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 4,	Sulphate of ammonia,	38
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 5,	Nitrate of soda,	47
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 6,	Dried blood,	75
	Sulphate of potash,	30
	Dissolved bone-black,	40

This proportion corresponds per acre to: —

	Pounds.
Phosphoric acid (available),	50.4
Nitrogen,	60.0
Potassium oxide,	120.0

A computation of the results of a chemical analysis of twenty prominent garden crops shows the average relative proportion of the three above-stated ingredients of plant food: —

	Per Cent.
Nitrogen,	2.2
Potassium oxide,	2.0
Phosphoric acid,	1.0

One thousand pounds of green garden vegetables contain on the above-stated basis of relative proportion of essential constituents of plant food: —

	Pounds.
Nitrogen,	4.1
Potassium oxide,	3.9
Phosphoric acid,	1.9

The weights and particular stage of growth of the vegetables when harvested control, under otherwise corresponding conditions, the actual consumption of each of these articles of plant food. Our information regarding these points is still too fragmentary to enable a more detailed statement here beyond relative proportions. It must suffice for the present to call attention to the fact that a liberal manuring within reasonable limits pays, as a rule, better than a scanty one, especially in the case of those crops which reach in a short period the desired state of maturity.

The various mixtures of fertilizers used in the experiments under discussion provided by actual supply for one-half of the available nitrogen actually called for to meet the demand as above pointed out. A liberal cultivation of peas and beans cannot fail to benefit the nitrogen resources of the soil. The order of arrangement of the different crops within each plat was the same in all of them for the same year.

They occupied, however, a different position relative to each other in successive years, to introduce, as far as practicable, a system of rotation of crops. (For details see previous annual report.)

Statement of Crops raised since 1891.

1891 and 1892.	1893.	1894.	1895 and 1896.
Celery.	Onions.	Onions.	Onions.
Lettuce.	Lettuce.	Sweet corn.	Sweet corn.
Spinach.	Spinach.	–	–
Beets.	Beans.	Beans.	Beans.
Cabbage.	–	–	–
Tomatoes.	Tomatoes.	Tomatoes.	Tomatoes.
Potatoes.	Potatoes.	–	–

Season of 1896. — The field was ploughed April 20. The fertilizers were the same as in the preceding years; each of the six plats received the same amount and kind of fertilizer, which was harrowed in April 24.

The crops raised during the season of 1896 were: —

Onions (Danvers Globe).
Tomatoes (Dwarf Champion).
Beans (Dwarf Horticultural).
Sweet Corn (Early Crosby).

Onions.

The seed was sown April 28. Each plat contained fifteen rows 14 inches apart; the weeds were kept down by frequent use of the hand cultivator; the crop was weeded by hand twice; the crop was rolled September 7. Those plats (4, 5, 6) which received their potash supply in form of high-grade sulphate of potash matured first, while those plats (1, 2, 3) receiving muriate of potash matured somewhat later. The crop upon Plat 1 was the latest to mature, while that upon Plat 2, receiving nitrate of soda, was the most advanced plat in the field. The onions were pulled September 7, topped October 5 and weighed October 9.

Yield of Onions (Pounds).

PLATS.	Large Onions.	Small Onions.	Scullions.	Total Yield.
Plat 1, . .	490	29	100	628
Plat 2, . .	697	24	30	751
Plat 3, . .	659	49	60	768
Plat 4, . .	489	26	55	570
Plat 5, . .	494	21	30	545
Plat 6, . .	595	54	50	699

Tomatoes.

It was deemed best in this experiment to procure an earlier maturing variety than the one used in the preceding year, to meet our market demands. The plants were started at the plant house of the horticultural department. The plants were set May 21 3 to 4 feet apart, two rows in each plat; each plat contained 44 plants; they were cultivated five times and hand-hoed three times.

Field C. Yield of Tomatoes (Pounds).

DATE OF PICKING.	Plat 1.	Plat 2.	Plat 3.	Plat 4.	Plat 5.	Plat 6.
July 18,	–	–	.40	–	–	.14
July 22,	.40	–	.12	–	–	.12
July 25,	1.10	.30	1.11	.30	.13	.12
July 28,	2.12	1.00	2.80	2.60	2.10	6.40
July 30,	3.20	2.10	2.80	1.14	4.00	3.40
August 1,	4.00	6.00	3.40	5.00	8.00	4.00
August 3,	8.40	6.80	8.80	7.00	5.80	7.00
August 5,	8.12	8.40	9.00	7.60	10.40	9.40
August 8,	10.12	15.00	15.00	13.80	17.00	18.00
August 10,	17.40	13.80	11.00	14.00	12.12	19.40
August 12,	7.40	8.80	5.00	12.00	13.40	9.40
August 15,	13.80	25.00	21.40	34.00	32.12	25.12
August 17,	17.00	44.80	21.12	45.00	49.40	36.12
August 19,	9.00	16.80	22.40	17.00	22.12	17.12
August 21,	6.12	14.80	18.40	7.80	15.40	8.40
August 24,	12.80	31.00	18.80	21.80	39.40	30.40
August 26,	13.12	33.80	17.00	20.00	35.80	26.80
August 29,	Not weighed.*	36.00	Not weighed.*	32.00	33.40	27.12
September 1,		50.80		49.12	68.40	53.00
September 4,		55.80		61.00	63.40	77.00
September 7,		48.80		44.00	54.00	63.00
September 11,		37.00		46.80	47.40	51.12
September 16,		34.00		55.00	35.00	42.00
September 21,		7.00		10.00	9.80	12.00
Green tomatoes,	28.00	10.80	40.00	24.00	9.00	14.00

* Records not complete.

Beans.

The beans were planted in rows 2½ feet apart, there being seven rows in each plat. The seed was planted May 19, the young plants appeared above ground June 1; they were cultivated five times and hand-hoed three times; the beans on all plats alike rusted badly. The beans were pulled and stacked in the field August 19.

Yield of Beans (Pounds).

PLATS.	Beans.	Pods and Vines.	Total Weight.
Plat 1, ...	31	30	61
Plat 2, ...	53	44	97
Plat 3, ...	52	44	96
Plat 4, ...	58	45	103
Plat 5, ...	67	51	118
Plat 6, ...	48	42	90

Sweet Corn.

Each plat contained five rows, the latter being 3 feet 3 inches apart; the hills were 20 inches apart, there being three plants left in each hill, making 1,060 hills per plat.

The crop appeared above ground June 1. It was subsequently cultivated five times and hand-hoed three times. In order to hasten maturity the stalks were topped September 9.

The corn was harvested and weighed October 9 with the following results: —

Sweet Corn (Early Crosby). Yield in Pounds per Plat.

PLATS.	Ears.	Stover.	Total Weight.
Plat 1, ...	190.0	250	445.0
Plat 2, ...	240.0	280	520.0
Plat 3, ...	195.0	335	530.0
Plat 4, ...	190.0	310	500.0
Plat 5, ...	182.5	290	472.5
Plat 6, ...	190.0	302	492.0

Conclusions drawn from Four Years of Observation.

1. Sulphate of potash in connection with nitrate of soda (Plat 5) has given in every case but one (onions) the best results.

2. Nitrate of soda as nitrogen source (plats 2 and 5) has yielded in almost every case, without reference to form of potash, the best results.

3. Sulphate of ammonia as a nitrogen source, in connection with muriate of potash as source of potash (Plat 1), has given as a rule the least satisfactory returns. This fact is evidently due to a change of chloride of potash and sulphate of ammonia into sulphate of potash and chloride of ammonium, the latter being an unfavorable form of nitrogen plant food.

4. The influence of the difference in the general character of the weather, whether normal or dry, during succeeding seasons on the yield of the crops has been greater than that of the different fertilizers used upon different plats during the same season.

Note. — The general management of the field work connected with the previously described continuation of my experiments was attended to by Mr. H. M. Thomson, Assistant Agriculturist of the Hatch Experiment Station, to whom I take pleasure in expressing my thanks for his cheerful assistance.

Part II.

REPORT ON THE WORK IN THE CHEMICAL LABORATORY.

Charles A. Goessmann.

1. On Official Inspection of Commercial Fertilizers and Agricultural Chemicals in 1896.

During the past year fifty-seven manufacturers and dealers in commercial fertilizers and agricultural chemicals have applied for and secured licenses for the sale of their goods in the State. Thirty-three of these parties have offices for general distribution within our State, nine in the State of New York, six in Connecticut, three in Vermont, three in Rhode Island, two in Pennsylvania and one in Illinois.

The number of distinct brands licensed, including agricultural chemicals, amounted to two hundred and sixty-five.

The sampling and collecting of the material for official analyses were in charge of Mr. H. D. Haskins, a graduate of the Massachusetts Agricultural College of the year 1890, and an efficient assistant in the chemical laboratory of the division of chemistry of the Experiment Station, who for several years in the past has attended to that part of the inspection in a very satisfactory manner.

Three hundred and twenty-eight samples were collected during the year, of which three hundred, representing two hundred and fifteen distinct brands, have been analyzed, and the results published in three bulletins, March, July and October, Numbers 38, 40 and 42 of the Hatch Experiment Station of the Massachusetts Agricultural College.

The modes of analyses adopted in this work were in all essential points those recommended by the Association of Official Chemists.

The results of the inspection have been on the whole quite satisfactory, as far as the compliance of the dealers with the provisions of our State laws for the regulation of the trade in commercial fertilizers is concerned. The variations here and there noticed between the guaranteed composition of the dealer and the results of our analyses could be traced with but few exceptions to imperfect mixing of the several ingredients of the fertilizer, and did not, as a rule, materially affect the commercial value of the article. In this connection attention should be called to the fact that the lowest amount stated in the guarantee is only legally binding.

To convey a more direct idea of the actual condition of this feature in the trade of commercial fertilizers of 1896, the following detailed statement is here inserted: —

(*a*) Where three essential elements of plant food were guaranteed: —

Number with three elements equal to or above the highest guarantee,	3
Number with two elements above the highest guarantee,	18
Number with one element above the highest guarantee,	65
Number with three elements between the lowest and highest guarantees,	26
Number with two elements between the lowest and highest guarantees,	60
Number with one element between the lowest and highest guarantees,	42
Number with two elements below the lowest guarantee,	8
Number with one element below the lowest guarantee,	59

(*b*) Where two essential elements of plant food were guaranteed: —

Number with two elements above the highest guarantee,	–
Number with one element above the highest guarantee,	16
Number with two elements between the lowest and highest guarantees,	13
Number with one element between the lowest and highest guarantees,	10
Number with one element below the lowest guarantee,	10

(*c*) Where one essential element of plant food was guaranteed: —

Number above the highest guarantee,	4
Number between the lowest and highest guarantees,	21
Number below the lowest guarantee,	11

The consumption of commercial fertilizers is steadily increasing, — a circumstance apparently not less due to a more general recognition of their good services, if judiciously selected and applied, than to gradual improvements in regard to their mechanical condition as well as their general chemical character. A noticeable change, referred to already in a previous report, regarding the chemical composition of many brands of so-called complete or formula fertilizers of to-day, as compared with those offered for similar purposes at an earlier period in the history of the trade in commercial fertilizers, consists in a more general and more liberal use of potash compounds as a prominent constituent. This change has been slow but decided, and in a large degree may be ascribed to the daily increasing evidence, resting on actual observations in the field and garden, that the farm lands of Massachusetts are quite frequently especially deficient in potash compounds, and consequently need in many instances a more liberal supply of available potash from outside sources to give satisfactory returns. Whenever the cultivation of garden vegetables, fruits and forage crops constitutes the principal products of the land, this recent change in the mode of manuring deserves in particular a serious trial; for the crops raised consume exceptionally large quantities of potash, as compared with grain crops. In view of these facts, it will be conceded that a system of manuring farm and garden which tends to meet more satisfactory recognized conditions of large areas of land, as well as the special wants of important growing branches of agricultural industries, is a movement in the right direction.

The present condition of the trade in commercial fertilizers offers exceptional advantages to provide efficient manures for the raising of farm and garden crops of every description congenial to soil and climate. The various essential articles of plant food, as potash, phosphoric acid and nitrogen compounds, are freely offered for sale in forms suitable to render the different kinds of the home manurial refuse material of the farm in a higher degree fit to meet the special wants of the crops to be raised.

Mixed fertilizers, designed to supply the essential articles of plant food with reference to the needs of special crops,

and containing them in every conceivable proportion, are asking for the patronage of all parties interested in the raising of plants.

A judicious management of the trade in commercial fertilizers implies a due recognition of well-established experimental results regarding the requirements of a remunerative production of farm and garden crops; yet, as the manufacturer at best can only prepare the composition of his special fertilizers on general lines, not knowing the particular condition and character of the soil which ultimately receives them, it becomes of the utmost importance on the part of the farmer to make himself acquainted with his special wants of manurial substances, and to thus qualify himself for a more judicious selection from the various fertilizers offered for his patronage.

For the reason that the physical conditions and chemical resources of soils on available plant food are frequently differing widely even on the same farm, no definite rule can be given for manuring farm lands, beyond the advice to return to the soil those plant constituents which the crops raised during preceding years have abstracted in an exceptionally large proportion, and which at the same time will be especially called for by the crops to be raised.

To select judiciously from among the agricultural chemicals and mixed fertilizers offered for sale for home use requires, in the main, three kinds of information: —

First. — A knowledge of the condition and the character of the soil to be prepared for cultivation.

Second. — An acquaintance with the composition of the crops, as far as the essential elements of plant food they contain are concerned.

Third. — A fair information regarding the general character, as well as the special composition, of the manurial substances offered for sale are concerned.

To assist as far as practicable in obtaining the above-stated desirable information, a compilation of the composition of our most prominent farm and garden crops, as well as the manurial substances and agricultural chemicals found in our markets, has been published from time to time in our annual reports, and will be found at the close of the present one.

List of Manufacturers and Dealers who have secured Certificates for the Sale of Commercial Fertilizers in This State during the Past Year (May 1, 1896, to May 1, 1897), and the Brands licensed by Each.

The Armour Fertilizer Works, Chicago, Ill.: —
Bone Meal.
Bone and Blood.
Ammoniated Bone and Potash.
All Soluble.
Bone, Blood and Potash.
Old Bog Cranberry Manure.

American Fertilizer Company, Boston, Mass.: —
Anti Acid Phosphate.
Alkaline Nitrate Phosphate for Hoed Crops.
Alkaline Nitrate Phosphate for Hay and Grain Crops.
Ward's Inodorous Plant Food.
Muriate of Potash.

Wm. H. Abbott, Holyoke, Mass.: —
Abbott's Fertilizer.
Abbott's Eagle Brand Fertilizer.

Bartlett & Holmes, Springfield, Mass.: —
Pure Ground Bone.
Animal Fertilizer.

H. J. Baker and Brother, New York, N. Y.: —
Standard Un X Ld Fertilizer.
Complete Strawberry Manure.
Complete Onion Manure.
Complete Potato Manure.
Complete Corn Manure.
A A Ammoniated Superphosphate.
Complete Tobacco Manure.
Grass and Lawn Dressing.
Vegetable, Vine and Potato Special.
Ground Bone.

C. A. Bartlett, Worcester, Mass.: —
Pure Ground Bone.
Animal Fertilizer.

The Berkshire Mills, Bridgeport, Conn.: —
Ammoniated Bone Phosphate.
Complete Fertilizer.

Bowker Fertilizer Company, Boston, Mass.: —
Stockbridge Special Manures.
Bowker's Hill and Drill Phosphate.
Bowker's Farm and Garden Phosphate.
Bowker's Lawn and Garden Dressing.
Bowker's Fish and Potash.
Bowker's Potato and Vegetable Manure.
Bowker's Market-garden Manure.
Bowker's Sure Crop Bone Phosphate.
Gloucester Fish and Potash.
Bowker's Dry Ground Fish.
Bowker's Fresh Ground Bone.
Nitrate of Soda.
Dried Blood.
Dissolved Bone-black.
Muriate of Potash.
Sulphate of Potash.
Sulphate of Ammonia.

Bradley Fertilizer Company, Boston, Mass.: —
Bradley's X L Superphosphate.
Bradley's Potato Manure.
Bradley's B D Sea Fowl Guano.
Bradley's Complete Manures.
Bradley's Fish and Potash.
Bradley's High-grade Tobacco Manure.
English Lawn Fertilizer.
Farmers' New Method Fertilizer.
Breck's Lawn and Garden Dressing.
Sulphate of Potash.
Muriate of Potash.
Nitrate of Soda.
Sulphate of Ammonia.
Dissolved Bone-black.
Fine-ground Bone.

William E. Brightman, Tiverton, R. I.: —
Brightman's Potato and Root Manure.
Brightman's Phosphate.
Brightman's Fish and Potash.

B. L. Bragg & Co., Springfield, Mass.: —
Hampden Lawn Dressing.

Butchers' Rendering Association, Saugus, Mass.: —
Ground Bone.
Champion Garden Fertilizer.

Daniel T. Church, Providence, R. I.: —
Church's B Special Fertilizer.
Church's C Standard Fertilizer.
Church's D Fish and Potash.

Clark's Cove Fertilizer Company, Boston, Mass.: —
Bay State Fertilizer.
Bay State Fertilizer, G G Brand.
Great Plant Manure.
Potato and Tobacco Manure.
King Philip Guano.
Potato Manure.
Fish and Potash.
White Oak Pure Ground Bone.
Muriate of Potash.
Sulphate of Potash.
Nitrate of Soda.

The Cleveland Dryer Company, Boston, Mass.: —
Cleveland Superphosphate.
Cleveland Potato Phosphate.
Cleveland Fertilizer.

E. Frank Coe Company, New York, N. Y.: —
E. Frank Coe's Excelsior Potato Fertilizer.
E. Frank Coe's High-grade Potato Fertilizer.
E. Frank Coe's Special Fertilizer.
E. Frank Coe's High-grade Ammoniated Bone Superphosphate.
E. Frank Coe's Fish Guano and Potash.
E. Frank Coe's Bay State Ammoniated Bone Superphosphate.
E. Frank Coe's Bay State High-grade Potato Fertilizer.

Crocker Fertilizer and Chemical Company, Buffalo, N. Y.: —
Crocker's General Crop Phosphate.
Crocker's New England Tobacco Grower.

Crocker Fertilizer and Chemical Company, Buffalo, N. Y. — *Concluded.*
- Muriate of Potash.
- Coolidge Brothers' Special Truck Fertilizer.
- Crocker's Ammoniated Bone Superphosphate.
- Crocker's Potato, Hop and Tobacco Phosphate.
- Crocker's Special Potato Manure.
- Crocker's Pure Ground Bone.
- Crocker's Practical Ammoniated Superphosphate.
- Crocker's New Rival Ammoniated Superphosphate.
- Crocker's Ammoniated Wheat and Corn Phosphate.
- Crocker's Ground Bone Meal.
- Crocker's Vegetable Bone Superphosphate.

Cumberland Bone Phosphate Company, Boston, Mass.: —
- Cumberland Superphosphate.
- Cumberland Potato Fertilizer.
- Cumberland Concentrated Phosphate.
- Cumberland Fertilizer.

L. B. Darling Fertilizer Company, Pawtucket, R. I.: —
- Animal Fertilizer.
- Extra Bone Phosphate.
- Potato and Root Fertilizer.
- Lawn and Garden Fertilizer.
- Tobacco Grower.
- Pure Fine Bone.
- Pure Dissolved Bone.
- Sulphate of Potash.

John C. Dow & Co., Boston, Mass.: —
- Superphosphate.
- Pure Bone.
- Bone Fertilizer.

Fyfe, Fay & Plummer, Clinton, Mass.: —
- Canada Wood Ashes.

Great Eastern Fertilizer Company, Rutland, Vt.: —
- Great Eastern General Fertilizer.
- Northern Corn Special.
- Soluble Bone and Potash.
- Vegetable, Vine and Tobacco Fertilizer.
- Garden Special Fertilizer.

Thomas Hersom & Co., New Bedford, Mass.: —
Bone Meal.

John G. Jefferds, Worcester, Mass.: —
Jefferds' Fine Ground Bone.
Jefferds' Potato Manure.
Jefferds' Animal Fertilizer.

Thomas Kirley, South Hadley Falls, Mass.: —
Kirley's Pride of the Valley.

A. Lee & Co., Lawrence, Mass.: —
The Lawrence Fertilizer.

Lowell Fertilizer Company, Lowell, Mass.: —
Lowell Bone Fertilizer.
Lowell Animal Fertilizer.
Lowell Potato Phosphate.
Lowell Vegetable and Vine Fertilizer.
Lowell Lawn Dressing.
Dissolved Bone and Potash.
Complete Manure for Potatoes and Vegetables.

Lowe Brothers & Co., Fitchburg, Mass.: —
Tankage.

The Mapes Formula and Peruvian Guano Company, New York, N. Y.: —
The Mapes Superphosphates.
The Mapes Bone Manures.
The Mapes Special Crop Manures.
Sulphate of Potash.
Double Manure Salts.
Nitrate of Soda.
Economical Manure.
Lawn Top-dressing with Plaster.

E. McGarvey & Co., successors to Forest City Wood Ash Company, Boston, Mass.: —
Unleached Wood Ashes.

McQuade Brothers, West Auburn, Mass.: —
Pure Ground Bone.

Monroe, Lalor & Co., Oswego, N. Y.: —
Unleached Wood Ashes.

National Fertilizer Company, Bridgeport, Conn.: —
Chittenden's Complete Fertilizers.
Chittenden's Ammoniated Bone.
Chittenden's Market-garden Fertilizer.
Chittenden's Fish and Potash.
Chittenden's Ground Bone.
Chittenden's Potato Phosphate.

Niagara Fertilizer Company, Buffalo, N. Y.: —
Niagara Wheat and Corn Producer.
Niagara Triumph.
Niagara Grain and Grass Fertilizer.
Niagara Potato, Tobacco and Hop Fertilizer.

Packers' Union Fertilizer Company, New York, N. Y.: —
Animal Corn Fertilizer.
University Fertilizer.
Oats and Clover Fertilizer.
Potato Manure.
Gardeners' Complete Manure.

Pacific Guano Company, Boston, Mass.: —
Soluble Pacific Guano.
Special Potato Manure.
Nobsque Guano.
Special for Potatoes and Tobacco.
Fish and Potash.
High-grade General Fertilizer.

Parmenter & Polsey Fertilizer Company, Peabody, Mass.: —
Plymouth Rock Brand.
Special Potato Fertilizer.
Special Strawberry Manure.
Star Brand Fertilizer.
Lawn Dressing.
Ground Bone.
Nitrate of Soda.
Muriate of Potash.

E. W. Perkins & Co., Rutland, Vt.: —
Plantene.

Prentiss, Brooks & Co., Holyoke, Mass. : —

Complete Manures.
Phosphate.
Nitrate of Soda.
Dissolved Bone-black.
Muriate of Potash.
Sulphate of Potash.
Fish and Potash.
Dry Ground Fish.

Preston Fertilizer Company, Green Point, L. I. : —

Pioneer Fertilizer.
Ammoniated Superphosphate.
Potato Fertilizer.

Quinnipiac Company, Boston, Mass. : —

Potato Manure.
Market-garden Manure.
Ammoniated Dissolved Bones.
Fish and Potash (Crossed Fishes).
Fish and Potash (Plain Brand).
Havana Tobacco Fertilizer.
Grass Fertilizer.
Corn Manure.
Potato and Tobacco Fertilizer.
Onion Manure.
Pure Bone Meal.
Dry Ground Fish.
Tankage.
Muriate of Potash.
Sulphate of Potash.
Nitrate of Soda.
Sulphate of Ammonia.
Dissolved Bone-black.
Phosphate.

Read Fertilizer Company, New York, N. Y. : —

Read's Standard.
High-grade Farmers' Friend.
Fish and Potash.
Vegetable and Vine Fertilizer.
Practical Potato Special Fertilizer.

N. Roy & Son, South Attleborough, Mass. : —
Complete Animal Fertilizer.

The Rogers & Hubbard Company, Middletown, Conn. : —
Pure Raw Knuckle Bone Flour.
Strictly Pure Fine Bone.
Soluble Potato Manure.
Soluble Tobacco Manure.
Fertilizer for Oats and Top-dressing.
Fairchild's Formula for Corn and General Crops.
Grass and Grain Fertilizer.

Russia Cement Company, Gloucester, Mass. : —
XXX Fish and Potash.
High-grade Superphosphate.
Special Manure for Potatoes, Roots and Vegetables.
Special Manure for Corn, Grain and Grass.
Odorless Lawn Dressing.
Dry Ground Fish.

Lucien Sanderson, New Haven, Conn. : —
Dissolved Bone-black.
Muriate of Potash.
Sulphate of Potash.
Nitrate of Soda.
Blood, Meat and Bone.
Formula A.

M. L. Shoemaker & Co., Limited, Philadelphia, Penn. : —
Swift and Sure Phosphate.
Swift and Sure Bone Meal.

Edward H. Smith, Northborough, Mass. : —
Fine-ground Bone.

Standard Fertilizer Company, Boston, Mass. : —
Standard Fertilizer.
Potato and Tobacco Fertilizer.
Standard Guano.
Fine-ground Bone.
Complete Manure.

Thomas L. Stetson, Randolph, Mass. : —
Fine-ground Bone.

F. C. Sturtevant, Hartford, Conn. : —
Ground Tobacco Stems.

Henry F. Tucker & Co., Boston, Mass. : —
Original Bay State Bone Superphosphate.
Imperial Bone Superphosphate.
Special Potato Fertilizer.

Walker, Stratman & Co., Pittsburg, Penn. : —
Potato Special.
Four Fold.
Smoky City.
Meadow King.

I. S. Whittemore, Wayland, Mass. : —
Whittemore's Complete Manure.

The Wilcox Fertilizer Works, Mystic, Conn. : —
Potato, Onion and Tobacco Manure.
Ammoniated Bone Phosphate.
High-grade Fish and Potash.
Dry Ground Fish Guano.
Fish and Potash, 1896 Brand.
Low-grade Sulphate of Potash.

Williams & Clark Fertilizer Company, Boston, Mass. : —
Superphosphate.
Potato Phosphate.
High-grade Special.
Fine Wrapper Tobacco Fertilizer.
Royal Bone Phosphate.
Corn Phosphate.
Potato and Tobacco Manure.
Grass Manure.
Fish and Potash.
Universal Ammoniated Dissolved Bone.
Prolific Crop Producer.
Onion Manure.
Pure Bone Meal.
Dry Ground Fish.
Tankage.
Muriate of Potash.
Sulphate of Potash.
Nitrate of Soda.
Dissolved Bone-black.
Sulphate of Ammonia.

M. E. Wheeler & Co., Rutland, Vt. : —
High-grade Fruit Fertilizer.
Grass and Oats Fertilizer.
Electrical Dissolved Bone.
Potato Manure.
High-grade Corn Fertilizer.
Superior Truck Fertilizer.

2. New Laws for the Regulation of the Trade in Commercial Fertilizers in Massachusetts.

[Acts of 1896, Chapter 297.]

An Act to regulate the Sale of Commercial Fertilizers.

Be it enacted, etc., as follows:

Section 1. Every lot or parcel of commercial fertilizer or fertilizer material sold or offered or exposed for sale within this Commonwealth shall be accompanied by a plainly printed statement, clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand or trade-mark under which the fertilizer is sold, the name and address of the manufacturer or importer, the location of the factory, and a chemical analysis stating the percentage of nitrogen, of potash soluble in distilled water, and of phosphoric acid in available form soluble in distilled water and reverted, as well as the total phosphoric acid. In the case of those fertilizers which consist of other and cheaper materials said label shall give a correct general statement of the composition and ingredients of the fertilizer it accompanies.

Sect. 2. Before any commercial fertilizer is sold or offered or exposed for sale the importer, manufacturer or party who causes it to be sold or offered for sale within this Commonwealth shall file with the director of the Hatch experiment station of the Massachusetts Agricultural College a certified copy of the statement named in section one of this act, and shall also deposit with said director at his request, a sealed glass jar or bottle, containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

Sect. 3. The manufacturer, importer, agent or seller of any brand of commercial fertilizer or fertilizer material shall pay for each brand, on or before the first day of May annually, to the director of the experiment station, an analysis fee of five dollars for each of the three following fertilizing ingredients: namely, nitrogen, phosphorus and potassium, contained or claimed to exist in said brand of fertilizer: *provided*, that whenever the manufact-

urer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee named in this section; and on receipt of said analysis fees and statement specified in section two the director of said station shall issue certificates of compliance with this act.

SECT. 4. No person shall sell or offer or expose for sale in this Commonwealth any pulverized leather, hair or wool waste, raw, steamed, roasted or in any form as a fertilizer, or as an ingredient of any fertilizer or manure, without an explicit printed certificate of the fact, said certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany or go with every parcel or lot of the same.

SECT. 5. Any person selling or offering or exposing for sale any commercial fertilizer without the statement required by the first section of this act, or with a label stating that said fertilizer contains a larger percentage of any one or more of the constituents mentioned in said section than is contained therein, or respecting the sale of which all the provisions of the foregoing section have not been fully complied with, shall forfeit fifty dollars for the first offence and one hundred dollars for each subsequent offence.

SECT. 6. This act shall not affect parties manufacturing, importing or purchasing fertilizers for their own use and not to sell in this Commonwealth.

SECT. 7. The director of the experiment station shall pay the analysis fees, as soon as received by him, into the treasury of the station, and shall cause one analysis or more of each fertilizer or fertilizer material to be made annually, and shall publish the results from time to time, with such additional information as the circumstances render advisable, provided such information relates only to the composition of the fertilizer or fertilizer material inspected. Said director is hereby authorized in person or by deputy to take a sample, not exceeding two pounds in weight, for analysis, from any lot or package of fertilizer or fertilizer material which may be in the possession of any manufacturer, importer, agent or dealer; but said sample shall be drawn in the presence of said party or parties in interest, or their representative, and taken from a parcel or a number of packages which shall be not less than ten per cent. of the whole lot inspected, and shall be thoroughly mixed and then divided into two equal samples and placed in glass vessels, and carefully sealed and a label placed on each, stating the name or brand of the fertilizer or material sampled, the name of the party from whose stock the sample was

drawn, and the time and place of drawing; and said label shall also be signed by the director or his deputy and by the party or parties in interest, or their representatives present at the drawing and sealing of said sample; one of said duplicate samples shall be retained by the director and the other by the party whose stock was sampled. All parties violating this act shall be prosecuted by the director of said station.

SECT. 8. Chapter two hundred and ninety-six of the acts of the year eighteen hundred and eighty-eight is hereby repealed.

SECT. 9. This act shall take effect on the first day of November in the year eighteen hundred and ninety-six. [*Approved April 17, 1896.*]

3. General Work in the Chemical Laboratory.

Analyses of materials sent on for examination.

Notes on basic phosphatic slag ("slag meal") as a fertilizer.

Action of chloride of potassium (muriate of potash) and chloride of sodium (common salt) on the lime resources of the soil.

Effect of chloride of potassium on sulphate of ammonium in mixed fertilizers.

Analyses of Materials sent on for Examination.

The constantly increasing variety of waste products of many branches of industry within our State and elsewhere, which have proved of manurial value, has received for years a serious attention. As a change in the current modes of manufacture of the parent industry is at any time liable to seriously affect the character and chemical composition of the waste or by products, it becomes necessary to repeat from time to time analyses of many of these products. These analyses are made, as far as our resources allow, without any charge for the work, on the condition that the results are public property if deemed of interest for publication.

A brief enumeration of the more prominent substances sent on for our investigation during the year 1896 may serve to convey a correct idea concerning the extent and importance of the labor involved. The whole number of substances analyzed in this connection during the year 1896 to December 1 amounts to 175: wood ashes, 51; cotton-seed-hull ashes, 7; swill ashes from cremation furnace, 1; rock phosphate, 4; acid phosphate, 4; phosphatic slag, 2; ground bones, tank-

age, dried fish and blood, 18; cotton-seed and linseed meal, 19; barn-yard manure, solid and liquid,. 11; cotton waste from factories, 6; potash salts of various descriptions, 18; dry Bordeaux mixtures, 10; Paris green, 8; miscellaneous analyses, 10; and compound fertilizers, 21.

The responsibility of the genuineness of all samples sent on for examination rests with the parties asking for analyses; the name of the localities they come from appears only in our published records of the work to prevent misunderstandings. The samples of fertilizers collected by responsible parties under the direction of the officer of this department alone are entered on our list of official analyses.

Notes on Basic Phosphatic Slag ("Slag Meal") as a Fertilizer.

This article appeared for the first time in our markets in 1886 under the name of phosphatic meal made of the Peine-Thomas Scoria, a by-product of a new process introduced into the manufacture of iron and steel from phosphorus containing iron ores.

The first sample received by me at Amherst was marked "R. Weichsel & Co., Magdeburg, Germany; phosphate meal made of the Peine-Thomas Scoria, guaranteed by Dr. Ulex of Hamburg, Germany, to contain 21.41 per cent. of phosphoric acid, corresponding to 46.74 per cent. of bone phosphate; Paul Weidinger & Co., New York, acting as agents."

The first lot sent on for field experiments consisted of 500 pounds of ground slag meal, also a mixture of 500 pounds of slag meal with 500 pounds of kainite; to the latter had been added some dry ground peat, to prevent caking. Pure slag meal, it is claimed, never hardens after being ground.

As the process of dephosphorizing the iron requires that the slag should be alkaline from the beginning, an excess of lime enters into the composition of the slag. To the presence of a certain amount of burned lime the phosphate meal owes, evidently, some of its good effects as a phosphoric acid source for plant food; incorporated in the soil, it absorbs moisture, and, like burned lime, it breaks up into an impal-

pable powder, which cannot fail to increase the availability of its phosphoric acid in a marked degree, as compared with other non-acidulated ground phosphates.

Not less beneficial must be considered in many instances the alkaline reaction of the genuine material, for it secures favorable conditions not only for a rapid decomposition ("nitrification") of the organic matter of the soil, but also for the disintegration of valuable mineral constituents of the soil, rendering in both directions inherent plant food more available. Much attention has been paid in Germany and England to experiments with slag meal as a phosphoric acid source of plant food, and many satisfactory results are reported. Our own observations are, to say the least, very encouraging, as may be seen from several annual reports since 1887.

Mixtures of phosphatic slag with nitrate of soda and the higher grades of potash salts have given in many instances much satisfaction. To secure the full benefit of the action of slag meal, it is desirable to scatter it broadcast late in the fall or early in the spring, and to plough it under at once from three to four inches; nitrate of soda and potash salts may be harrowed in later on, previous to seeding down.

The high price (from $20 to $25 per ton) of late charged for phosphatic slag meal of a varying composition and general character has discouraged its trial, as compared with the ground phosphate of South Carolina and Florida. As the high price has greatly interfered with a more general trial of slag meal, it is of interest to learn that arrangements are announced which will result in introducing large supplies of it at a much lower cost than before. A German syndicate, claiming to own the right of patent regarding the sale of Thomas slag in Europe and the United States, has established an office in Philadelphia, Penn., address Charles A. Voight, P. O. box 2133, Station A. In a recent communication from him it is stated the article will be offered for sale at from $8 to $9 per ton to farmers in the eastern States. The material consists of a dark, fine powder; it is sent out in 200 pound bags, with a guarantee of 18 per cent. of phosphoric acid. The station has secured a quantity for trial during the coming season.

Analysis of Phosphatic Slag Meal.

[I. Analyses of above-stated sample, 1896; II. Average of four analyses of earlier dates.]

	Per Cent.	
	I.	II.
Moisture,	1.45	1.45
Total phosphoric acid,	17.88	23.49
Calcium oxide (lime),	43.74	48.66
Magnesium oxide,	–*	3.42
Ferric and aluminic oxides,	25.25	10.12
Insoluble matter,	9.93	9.40

* Not determined.

Action of Chloride of Potassium (Muriate of Potash) and Chloride of Sodium (Common Salt) on the Lime Resources of the Soil.

In a previous bulletin, No. 38, issued March, 1896, by the Hatch Experiment Station, I called attention to an observation in connection with some field experiments, which showed that in several instances where, under otherwise corresponding circumstances, for several years muriate of potash had been liberally used as a potash source for a variety of crops, instead of sulphate of potash, an unhealthy appearance and lower yield of crop became from year to year more apparent. To correct this feature, from 350 to 400 pounds per acre of dry slacked lime were scattered broadcast over the surface of the soil, and ploughed under before manuring and seeding down the crop. The addition of lime gave excellent satisfaction, for the new crop looked healthy and vigorous, and the yield of the crop increased again fully to the average amount of the field. An examination of the drainage waters confirmed the view taken in the treatment of the field; the chlorides of calcium and magnesium were noticed to form prominent constituents of the

solid residue left after its evaporation. The amount of lime noticed in the drainage waters where muriate of potash had been added as a potash source was in every instance larger than where corresponding amounts of high-grade sulphate of potash were applied.

In publishing the results of our observations the following conclusions were offered for the consideration of farmers: —

(*a*) *The claim of both muriate and sulphate of potash, being economical and efficient forms to supply potash for growing crops, is so well established that no further endorsement is called for in this connection. Each form has its special merits with reference to particular fitness in case of different crops.*

(*b*) *The liberal use of muriate of potash as a fertilizer constituent renders, in cases where the lime resources of the soil under cultivation are limited, a periodical direct application of lime compounds as a manurial matter advisable.*

(*c*) *Muriate of potash is a safer source for manurial purposes upon a deep soil with a free subsoil than upon a shallow soil with a compact clayish subsoil, on account of a possible accumulation of the highly objectionable chlorides of calcium and magnesium (lime and magnesia) near the roots of the plants; both are known to prevent a healthy development of the root system.*

Repeated observations in the field and in the laboratory tend to confirm the above-stated conclusions; chloride of sodium (common salt) behaves in the same way as the chloride of potassium, — a fact which is readily proved by adding to any kind of a soil which is free from the chlorides of calcium some ground chalk and common salt, and after a week or so collecting and analyzing the percolating water; the presence of carbonic acid favors greatly the reaction; no good agricultural soil is free from carbonic acid or bicarbonates of lime and magnesium.

Effect of Chloride of Potassium (Muriate of Potash) on Sulphate of Ammonium in Mixed Fertilizers.

In studying the influence of the following mixtures of fertilizing materials, *i. e.*, —

PLATS.	Annual Supply of Manurial Substances.	Pounds.
Plat 1,	Sulphate of ammonia,	38
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 2,	Nitrate of soda,	47
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 3,	Dried blood,	75
	Muriate of potash,	30
	Dissolved bone-black,	40
Plat 4,	Sulphate of ammonia,	38
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 5,	Nitrate of soda,	47
	Sulphate of potash,	30
	Dissolved bone-black,	40
Plat 6,	Dried blood,	75
	Sulphate of potash,	30
	Dissolved bone-black,	40

on the yield and character of a variety of garden crops, it was noticed, with but one or two exceptions, that the fertilizers on Plat 1, consisting of dissolved bone-black, sulphate of ammonium and muriate of potash, produced the lowest yield of crop on trial; while the fertilizers on Plat 4, composed of corresponding quantities of dissolved bone-black, sulphate of ammonium and high-grade sulphate of potash, yielded, as a rule, a fair average crop. (For details, see preceding annual reports since 1892.)

As the season, character of the soil and mode of cultivation were practically the same in all cases, it seemed but natural to conclude that the fertilizers applied to Plat 1 suffered an unfavorable change when incorporated in the soil. An actual trial proved that a dry mixture of muriate of potash and sulphate of ammonium dissolved in water changes into sulphate of potash and chloride of ammonium (sal ammoniac); this form of nitrogen is known to act unfavorably on growing plants.

Most of our agricultural chemicals are liable to suffer chemical changes when used in mixed fertilizers; these changes are frequently not less depending on a mutual reac-

tion upon each other than on the general character and the particular chemical composition of the soil which receives them. The results of the chemical reactions between the saline constituents of the fertilizers and of the soil are as apt to benefit the crop as to injure it; the above-described observation furnishes an illustration of an injurious influence. Sulphate of ammonium is evidently a safer source of nitrogen for plant growth when used in connection with sulphate of potash than when used with muriate of potash (chloride of potassium).

4. Compilation of Analyses of Agricultural Chemicals, Manurial Substances, Fruits, Garden Crops and Insecticides.

Prepared by H. D. Haskins, Assistant Chemist,
Hatch Experiment Station.

1868 to 1897.

This compilation does not include the analyses made of licensed fertilizers. They are to be found in the reports of the State Inspector of Fertilizers from 1873 to 1896, contained in the reports of the Secretary of the Massachusetts State Board of Agriculture for those years, and in the bulletins of the department of chemistry of the Hatch Experiment Station of the Massachusetts Agricultural College since March, 1895.

As the basis of valuation changes from year to year, no valuation is stated in this compilation.

C. A. GOESSMANN.

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
I. Chemicals, Refuse, Salts, Ashes, etc.																							
Muriate of potash,	81	1.77	-	-	-	-	58.98	45.94	51.00	-	-	-	-	-	-	6.69	-	.55	-	-	-	48.80	.70
Sulphate of potash,	38	1.86	-	-	-	-	51.30	21.36	40.21	-	-	-	-	-	-	4.46	-	1.50	-	45.72	-	-	.75
Sulphate of potash-magnesia,	28	4.81	-	-	-	-	29.48	16.96	24.82	-	-	-	-	-	-	6.25	2.57	-	-	44.25	-	2.60	1.41
Carbonate of potash,	1	26.88	-	-	-	-	-	-	18.48	-	-	-	-	-	-	-	-	19.52	-	-	-	-	.39
Phosphate of potash,	1	3.76	-	-	-	-	-	-	32.56	-	-	37.50	-	-	-	-	-	-	-	13.43	-	-	.92
Kainite,	5	3.18	-	-	-	-	16.48	12.51	13.56	-	-	-	-	-	-	18.97	1.15	9.80	-	20.25	-	33.25	2.13
Carnallite,	1	-	-	-	-	-	-	-	13.68	-	-	-	-	-	-	7.66	-	13.19	-	.56	-	41.56	-
Krugite,	1	4.82	-	-	-	-	-	-	8.42	-	-	-	-	-	-	5.27	12.45	8.79	-	31.94	-	6.63	14.96
Sulphate of magnesia (Kieserite),	9	22.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.82	17.30	-	36.10	-	-	5.73
Nitrate of potash,	4	1.30	-	14.58	11.60	12.71	45.62	44.76	45.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate of soda,	37	1.38	-	16.22	14.28	15.04	-	-	-	-	-	-	-	-	-	35.50	-	-	-	-	-	.50	.50
Sulphate of ammonia,	28	1.06	-	21.68	19.59	22.03	-	-	-	-	-	-	-	-	-	-	-	-	-	60.00	-	-	-
Phosphate of ammonia,	1	6.05	-	-	-	10.37	-	-	-	-	-	43.86	-	-	-	-	-	-	-	12.46	-	-	.82
Sulphate of soda,	1	1.38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59.43	-	-	-
Saltpetre waste,	12	2.54	-	3.30	.52	2.22	30.94	1.55	13.66	-	-	-	-	-	-	37.04	.75	.19	-	1.85	-	46.25	-
Nitre salt-cake,	2	6.03	-	-	-	2.29	-	-	.87	-	-	-	-	-	-	29.56	-	-	-	47.77	-	-	3.92

Wood ashes,	527	10.38	-	-	-	-	10.80	1.20	5.39	5.58	.05	1.51	-	-	-	-	33.55	3.31	.96	-	-	-	16.28
Cotton-seed-hull ashes,	56	8.60	-	-	-	-	42.12	9.08	22.55	22.38	2.89	8.59	-	-	-	-	9.39	10.47	1.76	-	-	-	13.44
Ashes of spent tan-bark,	5	4.84	-	-	-	-	2.87	.60	1.81	2.77	.13	1.36	-	-	-	-	31.11	3.39	1.78	-	-	-	25.21
Corn-cob ashes,	1	1.20	-	-	-	-	-	-	7.08	-	-	2.37	-	-	-	-	11.70	-	1.28	-	-	-	52.09
Railroad-tie ashes,	1	4.70	-	-	-	-	-	-	.92	-	-	.56	-	-	-	-	2.51	-	-	-	-	-	80.20
Peat ashes,	1	4.67	-	-	-	-	-	-	.46	-	-	.11	-	-	-	-	2.28	1.63	6.13	-	-	-	45.17
Logwood ashes,	1	1.50	-	-	-	-	-	-	.08	-	-	2.30	-	-	-	-	3.90	-	-	-	-	-	9.70
Hard-pine wood ashes,	1	.75	-	-	-	-	-	-	10.16	-	-	2.24	-	-	-	-	24.95	-	-	-	-	-	29.90
Mill ashes,	1	.53	-	-	-	-	-	-	1.60	-	-	.46	-	-	-	-	34.93	1.35	-	-	-	-	36.36
Ashes from cremation of swill,	15	4.86	-	-	-	-	8.83	1.25	3.97	32.36	7.47	14.16	-	-	-	-	33.58	1.87	4.65	-	-	-	21.57
Ashes from blue works,	1	12.14	63.78	-	-	-	-	-	9.02	-	-	-	-	-	-	-	-	-	-	-	-	-	12.30
Sea-weed ashes,	1	1.47	-	-	-	-	-	-	.92	-	-	.30	-	-	-	8.76	6.06	4.37	-	2.98	-	6.60	63.65
Gypse,	1	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50.87	-	-	-	-	-	2.87
Nova Scotia plaster (gypsum),	16	8.95	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32.85	.75	-	44.87	-	-	3.47
Onondaga plaster (New York gypsum),	4	13.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.00	4.66	-	32.50	8.20	-	9.83
Lime,	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	93.63	-	-	-	-	-	1.33
Waste lime,	1	.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	74.12	-	-	-	-	-	.38
Gas-house lime,	3	22.28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43.66	8.30	-	20.73	-	-	6.05
Lime waste from sugar factory,	1	36.30	-	-	-	-	-	-	.22	-	-	2.25	-	-	-	-	27.51	-	-	-	-	-	.32
Lime kiln ashes,	17	14.48	-	-	-	-	2.78	.02	1.28	3.16	.36	1.09	-	-	-	-	42.57	2.60	-	-	17.75	-	7.69
Bituminous coal ashes,	2	3.66	-	-	-	-	-	-	.38	-	-	.44	-	-	-	-	1.88	-	-	-	-	-	74.17
Carbonate of lime,	1	.47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52.98	-	-	-	-	-	-

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
I. Chemicals, Refuse, Salts, Ashes, etc. — Concluded.																							
Marls (Massachusetts),	7	13.70	-	-	-	-	-	-	.24	2.72	.06	1.05	-	-	-	-	40.50	.64	.69	-	28.57	-	3.44
Marls (Virginia),	2	15.98	-	-	-	-	.61	.37	.49	.09	.08	.09	-	-	-	-	7.25	.21	-	.66	7.25	-	64.23
Green sand marl (Virginia),	1	1.25	-	-	-	-	-	-	1.14	-	-	9.37	-	-	-	-	25.78	-	5.13	-	-	-	41.32
Olive earth (Virginia),	1	1.97	-	-	-	-	-	-	.24	-	-	13.73	-	-	-	-	19.16	-	6.00	-	-	-	50.55
Ammoniated marl,	1	3.31	-	-	-	1.61	-	-	-	-	-	10.39	-	.41	9.98	-	-	-	-	-	-	-	-
Marl (North Carolina),	1	1.50	-	-	-	-	-	-	.04	-	-	.56	-	-	-	-	21.95	.61	-	-	-	-	50.18
Clay (so called),	1	.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	54.35	1.04	2.80	-	37.32	-	2.57
II. Guanos, Phosphates, etc.																							
Peruvian guano,	26	14.81	37.61	13.50	4.44	7.85	4.08	1.14	2.61	20.60	5.96	15.26	4.57	3.79	6.90	-	-	-	-	-	-	-	6.60
Bat guano from Texas,	9	40.09	18.24	10.51	2.58	6.47	-	-	1.31	6.53	1.00	3.76	-	-	-	-	-	-	-	-	-	-	2.00
Bat guano from Florida,	2	15.66	-	-	-	9.74	-	-	1.77	3.44	3.26	3.35	-	-	-	-	-	-	-	-	-	-	19.33
Rat guano from Florida,	1	10.32	-	-	-	3.32	-	-	6.85	-	-	2.30	-	-	-	-	-	-	-	-	-	-	1.15
Cuban guano,	5	24.27	-	2.74	.63	1.67	-	-	-	16.16	11.54	13.35	-	-	-	-	-	-	-	-	-	-	3.17
Caribbean guano (orchilla),	12	7.31	-	-	-	-	-	-	-	35.43	18.11	26.77	-	-	-	-	39.95	3.29	-	2.68	-	-	1.27
Mona Island guano,	1	13.32	-	-	-	.76	-	-	-	-	-	21.88	-	7.55	14.33	-	37.49	-	-	-	-	-	2.45

South Carolina rock phosphate,	7	1.36	-	-	-	-	-	-	-	30.51	24.70	27.42	.27	.07	27.13	-	41.87	3.03	4.80	-	-	-	9.04
South Carolina floats,	1	.83	-	-	-	-	-	-	-	-	-	23.39	-	2.33	21.06	-	-	-	-	-	-	-	20.16
Florida rock phosphate,	31	2.00	-	-	-	-	-	-	.21	38.97	6.95	26.02	-	1.47	19.70	-	30.40	-	7.68	-	2.08	-	27.29
Soft Florida phosphate,	3	4.87	-	-	-	-	-	-	-	19.94	17.71	18.73	-	-	-	-	23.72	-	6.82	-	-	-	20.92
Navassa phosphate,	2	7.60	-	-	-	-	-	-	-	34.45	34.09	34.27	-	-	-	-	37.45	-	10.27	-	-	-	2.70
Brockville phosphate,	1	2.50	-	-	-	-	-	-	-	-	-	35.21	-	-	-	-	-	-	-	-	-	-	6.46
Phosphatic slag,	4	1.45	-	-	-	-	-	-	-	30.51	18.91	23.49	-	3.06	21.65	-	48.66	3.42	10.12	-	-	-	9.40
Odorless phosphate,	6	2.99	-	-	-	-	.52	.04	.38	21.74	18.40	19.54	-	.52	19.82	-	51.42	-	-	-	2.51	-	9.14
Dissolved bone-black,	7	10.17	47.50	-	-	-	-	-	-	17.80	14.99	16.25	15.61	1.15	.37	-	-	-	-	-	-	-	3.99
Upton phosphate,	1	9.07	-	-	-	-	-	-	-	-	-	40.15	-	37.84	2.31	-	-	-	-	-	-	-	-
Bone-black,	5	4.60	-	-	-	-	-	-	-	30.54	16.56	28.28	-	-	-	-	-	-	-	-	-	-	3.64
Double superphosphate,	1	5.74	-	-	-	-	-	-	-	-	-	47.80	38.38	9.04	.38	-	16.00	-	-	1.19	-	-	.60
South American bone-ash,	1	7.00	-	-	-	-	-	-	-	-	-	35.89	-	-	-	-	44.89	-	-	-	-	-	4.50
Acid phosphate,	1	14.23	69.95	-	-	-	-	-	-	-	-	14.64	10.34	2.42	1.88	-	-	-	-	-	-	-	10.81
III. Refuse Substances.																							
Dried blood,	19	11.43	6.37	13.55	8.10	10.43	-	-	-	8.70	1.30	2.64	-	-	-	-	-	-	-	-	-	-	-
Ammonite,	1	5.88	-	-	-	11.33	-	-	-	-	-	3.43	-	-	-	-	-	-	-	-	-	-	1.38
Oleomargarine refuse,	1	8.54	14.42	-	-	12.12	-	-	-	-	-	.88	-	-	-	-	-	-	-	-	-	-	.96
Felt refuse,	1	29.24	33.53	-	-	5.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sponge refuse,	1	7.25	-	-	-	2.43	-	-	-	-	-	3.19	-	-	-	-	3.94	1.27	-	-	-	-	39.05
Blood and bone,	2	8.36	-	6.80	6.68	6.74	-	-	-	11.39	10.62	11.01	-	2.82	7.80	-	-	-	-	-	-	-	-
Horn shavings,	1	4.83	-	-	-	15.31	-	-	-	-	-	.42	-	-	-	-	-	-	-	-	-	-	-

	Analyses.	Moisture.	Ash.	Nitrogen.			Potash.			Total Phosphoric Acid.			Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
				Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.											
III. Refuse Substances — Continued.																							
Ivory dust,	1	11.50	52.63	-	-	6.64	-	-	-	-	-	24.56	.97	17.97	5.62	-	-	-	-	-	-	-	-
Horn and hoof waste,	3	10.17	7.63	15.49	11.84	13.25	-	-	-	2.30	1.36	1.83	-	-	-	-	-	-	-	-	-	-	.24
Raw wool,	1	6.95	7.54	-	-	12.88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.63
Wool waste,	11	11.77	24.10	10.20	.96	4.56	3.50	.06	1.68	.67	.05	.31	-	-	-	-	.11	.06	.80	-	-	-	8.20
Wool washings (water),	1	-	-	-	-	-	-	-	3.92	-	-	-	-	-	-	.49	.28	-	-	-	-	-	-
Wool washings (acid),	1	-	-	-	-	-	-	-	4.20	-	-	-	-	-	-	.40	.61	.20	-	-	-	-	-
Wool washings (alkaline),	1	92.03	3.28	-	-	.09	-	-	1.09	-	-	-	-	-	-	.92	.04	-	-	-	-	-	.22
Morocco factory waste,	1	22.72	-	-	-	1.16	-	-	.36	-	-	2.56	-	-	-	-	19.60	-	-	1.24	-	-	24.17
Meat scrap,	2	24.79	-	-	-	6.33	-	-	-	-	-	5.79	-	-	-	-	-	-	-	-	-	-	-
Meat mass,	5	12.09	13.60	11.50	9.69	10.44	-	-	-	3.58	.56	2.07	-	-	-	-	-	-	-	-	-	-	.58
Bone soup,	1	82.92	7.07	-	-	1.14	-	-	-	-	-	1.26	-	-	-	-	-	-	-	-	-	-	-
Dried soup from meat and bone,	1	14.80	8.40	-	-	9.97	-	-	-	-	-	.53	-	-	-	-	-	-	-	-	-	-	.64
Dried soup from rendering cattle feet,	1	10.80	7.50	-	-	14.47	-	-	-	-	-	.46	-	-	-	-	-	-	-	-	-	-	.26
Dried soup from horse rendering,	1	92.14	-	-	-	1.12	-	-	-	-	-	.14	-	-	-	-	-	-	-	-	-	-	-
Soap-grease refuse,	2	29.25	51.39	4.20	2.21	3.21	-	-	-	15.37	11.04	13.21	-	-	-	-	-	-	-	-	-	-	1.29
Bones,	170	6.76	53.03	4.70	1.57	3.87	-	-	-	32.52	15.16	22.43	.38	8.62	13.77	-	-	-	-	-	-	-	1.08

Meat and bone,	2	5.26	-	-	-	4.57	-	-	-	-	-	20.21	.26	7.03	13.05	-	-	-	-	-	-	-	1.22
Tankage,	19	8 20	-	9.16	2.66	6.14	-	-	-	24.30	1.72	12.84	-	4.06	7.46	-	-	-	-	-	-	-	-
Fish with less than twenty per cent. water,	73	12.18	21.50	11.40	5.97	7.58	-	-	-	15.91	5.50	8.48	.55	2.64	5.06	-	-	-	-	-	-	-	2.01
Fish with between twenty and forty per cent. water.	10	30.19	20.59	7.41	4.22	5.97	-	-	-	8.32	4.68	7.09	.74	2.69	3.64	-	-	-	-	-	-	-	1.68
Fish with more than forty per cent. water,	10	45.46	15.50	7.60	2.43	4.97	-	-	-	8.56	2.94	5.08	1.17	1.33	2.58	-	-	-	-	-	-	-	1.35
Whale meat, raw,	1	44.50	1.04	-	-	4.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lobster shells,	1	7.27	-	-	-	4.50	-	-	-	-	-	3.52	-	-	-	-	22.24	1.30	-	-	-	-	.27
Castor-bean pomace,	6	9.68	5.70	5.72	5.22	5.51	3.40	.64	1.57	2.26	1.57	2.18	-	-	-	-	.87	.29	-	-	-	-	1.75
Cotton-seed meal,	50	7.05	5.78	7.95	2.05	6.60	2.38	.48	1.76	3.36	.73	1.79	-	-	-	-	-	-	-	-	-	-	.28
Linseed meal,	2	8.43	-	-	-	6.34	-	-	1.25	-	-	1.84	-	-	-	-	-	-	-	-	-	-	-
Rotten brewers' grain,	1	78.77	-	-	-	.72	-	-	.04	-	-	.43	-	-	-	-	.26	.15	-	-	-	-	.59
Mill sweepings,	1	9.49	-	-	-	3.76	-	-	.66	-	-	1.18	-	-	-	-	-	-	-	-	-	-	5.01
Tobacco leaf,	1	13.05	21.01	-	-	2.75	-	-	7.24	-	-	.43	-	-	-	-	4.17	2.17	.32	-	-	-	4.17
Tobacco stems,	7	10.61	14.07	2.91	.90	2.30	10.60	3.76	7.03	2.09	.44	.62	-	-	-	.34	3.89	1.23	-	-	-	-	.82
Cotton waste, wet,	1	34.69	-	-	-	1.30	-	-	.80	-	-	1.54	-	-	-	-	2.45	1.13	-	-	-	-	41.33
Cotton waste, dry,	4	5.87	60.60	9.33	.96	1.77	1.76	.66	1.42	1.80	.26	.45	-	-	-	-	-	-	-	-	-	-	32.59
Refuse from calico works,	1	4.07	-	-	-	4.28	-	-	-	-	-	11.95	-	-	-	-	-	-	-	-	-	-	-
Cotton dust,	2	32.68	50.93	-	-	.78	-	-	.45	-	-	.32	-	-	-	-	-	-	-	-	-	-	42.22
Glucose refuse,	1	8.10	-	-	-	2.62	-	-	.15	-	-	.29	-	-	-	-	.18	.02	-	-	-	-	.07
Waste from lactate factory,	1	34.11	-	-	-	.68	-	-	-	-	-	.67	-	-	-	-	22.59	-	-	-	-	-	6.92
Hop refuse,	1	8.98	-	-	-	.98	-	-	.11	-	-	.20	-	-	-	-	.27	.10	-	-	-	-	.63
Banana skins,	1	13.99	-	-	-	.24	-	-	5.46	-	-	1.80	-	-	-	-	-	-	-	-	-	-	-

	Analyses.	Moisture.	Ash.	Nitrogen. Maximum.	Nitrogen. Minimum.	Nitrogen. Average.	Potash. Maximum.	Potash. Minimum.	Potash. Average.	Total Phosphoric Acid. Maximum.	Total Phosphoric Acid. Minimum.	Total Phosphoric Acid. Average.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
III. Refuse Substances — Concluded.																							
Tankage and blood,	1	14.43	-	-	-	5.88	-	-	-	-	-	6.84	5.44	1.08	.32	-	-	-	-	-	-	-	-
Sumac waste,	1	63.06	6.80	-	-	1.19	-	-	3.25	-	-	-	-	-	-	-	1.14	3.25	-	-	-	-	2.25
Eel grass,	2	35.39	15.60	.96	.70	.83	1.61	.21	.91	.41	.22	.32	-	-	-	1.63	2.13	.11	-	-	-	-	1.06
Pine-barren grass,	1	8.48	2.40	-	-	.16	-	-	.07	-	-	.18	-	-	-	-	-	-	-	-	-	-	1.67
Pine needles,	1	9.48	3.42	-	-	.46	-	-	.03	-	-	.12	-	-	-	-	-	-	-	-	-	-	1.22
Rockweed, green,	1	68.50	23.70	-	-	.62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rockweed, dry,	1	10.68	35.75	-	-	1.45	-	-	4.89	-	-	2.75	-	-	-	7.90	7.66	.21	-	-	-	-	10.40
Jute waste,	1	13.10	-	-	-	1.50	-	-	.08	-	-	.72	-	-	-	-	-	-	-	-	-	-	-
Hair waste,	1	72.81	-	-	-	1.39	-	-	.32	-	-	.61	-	-	-	-	-	-	-	-	-	-	-
Starch waste from rubber factory,	1	10.01	.23	-	-	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sludge from sewage precipitating tanks,	1	88.49	9.50	-	-	.05	-	-	.05	-	-	.10	-	-	-	-	1.58	.39	6.22	-	-	-	.93
Sludge,	1	6.28	-	-	-	.68	-	-	-	-	-	1.36	-	-	-	-	8.66	-	17.68	-	-	-	38.03
Residue from water filter,	1	94.22	-	-	-	.12	-	-	-	-	-	.05	-	-	-	-	-	-	-	-	-	-	-
Blue-green algæ (*Lyngbia majuscula*), dry,	1	16.26	-	-	-	4.25	-	-	.79	-	-	.19	-	-	-	3.53	2.06	1.18	-	-	-	-	5.53
Mussel mud, wet,	1	60.01	27.29	-	-	.21	-	-	6.17	-	-	.10	-	-	-	.70	.93	.14	3.48	-	-	-	-
Mussel mud, dry,	1	2.24	72.02	-	-	.72	-	-	-	-	-	.35	-	-	-	-	23.39	-	8.26	-	-	-	37.60

Madder,	2	11.93	-	-	-	.91	-	-	2.40	-	-	.35	-	-	-	-	3.93	.51	-	-	-	-	4.67
Salt mud,	2	53.37	41.19	.40	.39	.40	.33	.32	.33	-	-	-	-	-	-	.94	.91	.37	4.13	-	-	-	34.88
Fresh-water mud,	1	40.37	-	-	-	1.37	-	-	.22	-	-	.26	-	-	-	-	1.27	.29	1.80	-	-	-	18.26
Muck,	25	61.69	13.75	2.54	.12	.79	-	-	-	.17	.08	.13	-	-	-	-	-	-	-	-	-	-	10.68
Peat, wet,	11	61.36	7.66	1.40	.41	.85	-	-	.18	-	-	.09	-	-	-	-	.55	.72	2.14	-	-	-	2.14
Peat, dry,	2	14.67	17.26	-	-	1.89	-	-	.06	-	-	.03	-	-	-	-	-	-	-	-	-	-	10.14
Turf,	2	19.29	6.36	1.97	1.91	1.94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soot,	7	4.29	77.10	1.05	.09	.41	1.83	.21	.63	2.10	.19	1.13	-	-	-	-	2.99	1.19	6.38	-	-	-	66.06
IV. Animal Excrement, etc.																							
Barn-yard manure,	79	67.24	-	1.36	.21	.52	1.40	.13	.56	.75	.10	.39	-	-	-	-	.30	.19	-	-	-	-	8.00
Horse manure,	1	11.24	-	-	-	.74	-	-	2.82	-	-	1.46	-	-	-	-	-	-	-	-	-	-	12.60
Sheep manure,	4	29.22	-	-	-	1.44	-	-	1.17	-	-	.92	-	-	-	-	-	-	-	-	-	-	12.91
Drainage from a manure heap,	1	93.20	3.66	-	-	.98	-	-	.88	-	-	.24	-	-	-	-	-	-	-	-	-	-	-
Poudrette, dry,	1	5.25	35.45	-	-	3.58	-	-	.49	-	-	5.74	-	-	-	-	-	-	-	-	-	-	4.65
Goose manure,	1	48.92	-	-	-	.21	-	-	.81	-	-	.95	-	-	-	-	-	-	-	-	-	-	-
Hen manure, fresh,	2	52.35	24.75	1.20	.79	.99	.32	.18	.25	1.00	.47	.74	-	-	-	-	1.19	.89	-	1.24	-	-	23.50
Hen-house refuse,	2	7.37	-	-	-	.71	-	-	1.03	-	-	1.02	-	-	-	-	-	-	-	-	-	-	71.07

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
I. Chemicals, Refuse, Salts, Ashes, etc.													
Muriate of potash,	35.	-	-	1,020.	-	134.	-	11.	-	-	-	976.	14.
Sulphate of potash (high grade),	37.	-	-	804.	-	89.	-	30.	-	914.	-	-	15.
Sulphate of potash-magnesia,	96.	-	-	496.	-	125.	51.	-	-	885.	-	52.	28.
Carbonate of potash,	538.	-	-	370.	-	-	-	390.	-	-	-*	-	8.
Phosphate of potash,	75.	-	-	651.	750.	-	-	-	-	269.	-	-	18.
Kainite,	64.	-	-	271.	-	379.	23.	196.	-	405.	-	665.	43.
Carnallite,	-	-	-	274.	-	153.	-	264.	-	11.	-	831.	-
Krugite,	96.	-	-	168.	-	105.	249.	176.	-	639.	-	133.	299.
Sulphate of magnesia (kieserite),	454.	-	-	-	-	-	56.	346.	-	722.	-	-	115.
Nitrate of potash,	26.	-	254.	905.	-	-	-	-	-	-	-	-	-
Nitrate of soda,	28.	-	301.	-	-	710.	-	-	-	-	-	10.	10.
Sulphate of ammonia,	212.	-	441.	-	-	-	-	-	-	1,200.	-	-	-
Phosphate of ammonia,	120.	-	207.	-	877.	-	-	-	-	249.	-	-	16.
Sulphate of soda,	28.	-	-	-	-	-	-	-	-	1,189.	-	-	-
Saltpetre waste,	51.	-	44.	273.2	-	740.8	15.	38.	-	37.	-	925.	-

Nitre salt-cake,	121.	-	56.	17.	-	591.	-	-	-	955.	-	-	78.
Wood ashes,	208.	-	-	108.	30.	-	671.	66.	19.	-	-	-	326.
Cotton-seed-hull ashes,	172.	-	-	451.	172.	-	188.	209.	35.	-	-	-	269.
Ashes of spent tan-bark,	97.	-	-	36.	37.	-	622.	68.	36.	-	-	-	504.
Corn-cob ashes,	24.	-	-	142.	47.	-	234.	-	26.	-	-	-	1,042.
Railroad-tie ashes,	94.	-	-	18.	11.	-	50.	-	-	-	-	-	1,604.
Peat ashes,	93.	-	-	9.	2.	-	46.	33.	123.	-	-	-	903.
Logwood ashes,	30.	-	-	2.	56.	-	78.	-	-	-	-	-	194.
Hard-pine wood ashes,	15.	-	-	203.	45.	-	499.	-	-	-	-	-	598.
Mill ashes,	11.	-	-	32.	9.	-	699.	27.	-	-	-	-	727.
Ashes from cremation of swill,	97.	-	-	79.	283.	-	672.	27.	93.	-	-	-	431.
Ashes from blue works,	243.	1,276.	-	180.	-	-	-	-	-	-	-	-	246.
Seaweed ashes,	29.	-	-	18.	6.	175.	121.	87.	-	60.	-	132.	1,273.
Gypse,	33.	-	-	-	-	-	1,017.	-	-	-	-	-	57.
Nova Scotia plaster (gypsum),	179.	-	-	-	-	-	657.	15.	-	897.	-	-	69.
Onondaga plaster (New York gypsum),	265.	-	-	-	-	-	606.	93.	-	650.	164.	-	187.
Lime (burnt),	-	-	-	-	-	-	1,973.	-	-	-	-	-	27.
Waste lime,	16.	-	-	-	-	-	1,482.	-	-	-	-	-	8.
Gas-house lime,	446.	-	-	-	-	-	873.	166.	-	415.	-	-	121.
Lime waste from sugar factory,	726.	-	-	4.	45.	-	550.	-	-	-	-	-	6.
Lime-kiln ashes,	290.	-	-	26.	22.	-	851.	52.	-	-	355.	-	154.
Bituminous coal ashes,	73.	-	-	8.	9.	-	38.	-	-	-	-	-	1,483.

* Not determined.

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Continued.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
I. Chemicals, Refuse, Salts, Ashes, etc. — Concluded.													
Carbonate of lime,	9.	-	-	-	-	-	1,060.	-	-	-	-	-	-
Marls (Massachusetts),	274.	-	-	5.	21.	-	810.	13.	14.	-	571.	-	69.
Marls (Virginia),	320.	-	-	10.	2.	-	145.	4.	-	13.	145.	-	1,285.
Green sand marls (Virginia),	25.	-	-	23.	187.	-	516.	-	103.	-	-	-	826.
Olive earth (Virginia),	39.	-	-	5.	275.	-	383.	-	120.	-	-	-	1,011.
Ammoniated marl,	66.	-	32.	-	208.	-	-	-	-	-	-	-	-
Marl (North Carolina),	30.	-	-	1.	11.	-	439.	12.	-	-	-	-	1,004.
II. Guanos, Phosphates, etc.													
Peruvian guano,	296.	752.	157.	52.	305.	-	-	-	-	-	-	-	132.
Bat guano from Texas,	802.	365.	129.	26.	75.	-	-	-	-	-	-	-	40.
Bat guano from Florida,	313.	-	195.	25.	67.	-	-	-	-	-	-	-	387.
Rat guano from Florida,	206.	-	66.	137.	46.	-	-	-	-	-	-	-	23.
Cuban guano,	485.	-	33.	-	267.	-	-	-	-	-	-	-	63.
Caribbean guano (orchilla),	146.	-	-	-	535.	-	799.	66.	-	54.	-	-	25.
Mona Island guano,	266.	-	15.	-	438.	-	750.	-	-	-	-	-	49.

South Carolina rock phosphate,	27.	-	-	-	549.	-	837.	61.	96.	-	-	-	181.
South Carolina floats,	17.	-	-	-	468.	-	-	-	-	-	-	-	403.
Florida rock phosphate,	40.	-	-	4.	520.	-	608.	-	154.	-	22.	-	546.
Soft Florida phosphate,	97.	-	-	-	375.	-	274.	-	136.	-	-	-	418.
Navassa phosphate,	152.	-	-	-	685.	-	749.	-	205.	-	-	-	54.
Brockville phosphate,	50.	-	-	-	704.	-	-	-	-	-	-	-	129.
Phosphatic slag,	29.	-	-	-	470.	-	973.	68.	202.	-	-	-	188.
Odorless phosphate,	60.	-	-	8.	391.	-	1,028.	-	-	-	50.	-	183.
Dissolved bone-black,	203.	950.	-	-	325.	-	-	-	-	-	-	-	80.
Upton phosphate,	181.	-	-	-	803.	-	-	-	-	-	-	-	-
Bone-black,	92.	-	-	-	565.	-	-	-	-	-	-	-	73.
Double superphosphate,	115.	-	-	-	956.	-	320.	-	-	24.	-	-	12.
South American bone ash,	140.	-	-	-	718.	-	898.	-	-	-	-	-	90.
Acid phosphate,	285.	1,399.	-	-	293.	-	-	-	-	-	-	-	216.
III. Refuse Substances.													
Dried blood,	229.	127.	209.	-	53.	-	-	-	-	-	-	-	-
Ammonite,	118.	-	227.	-	69.	-	-	-	-	-	-	-	28.
Oleomargarine refuse,	171.	288.	242.	-	18.	-	-	-	-	-	-	-	19.
Felt refuse,	585.	671.	105.	-	-	-	-	-	-	-	-	-	-
Sponge refuse,	145.	-	49.	-	64.	-	79.	25.	-	-	-	-	781.
Blood and bone,	167.	-	135.	-	220.	-	-	-	-	-	-	-	-
Horn shavings,	99.	-	306.	-	8.	-	-	-	-	-	-	-	-

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Continued.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid.	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
III. Refuse Substances — Continued.													
Ivory dust,	230.	1,053.	133.	-	491.	-	-	-	-	-	-	-	-
Horn and hoof waste,	203.	153.	265.	-	37.	-	-	-	-	-	-	-	5.
Raw wool,	139.	151.	258.	-	-	-	-	-	-	-	-	-	72.
Wool waste,	235.	582.	91.	34.	6.	-	2.	1.	16.	-	-	-	164.
Wool washings (water),	-	-	-	78.	-	10.	6.	-	-	-	-	-	-
Wool washings (acid),	-	-	-	84.	-	8.	12.	4.	-	-	-	-	-
Wool washings (alkaline),	1,841.	66.	2.	22.	-	18.	1.	-	-	-	-	-	4.
Morocco factory waste,	454.	-	23.	7.	51.	-	392.	-	-	25.	-	-	483.
Meat scrap,	496.	-	127.	-	116.	-	-	-	-	-	-	-	-
Meat mass,	242.	272.	209.	-	41.	-	-	-	-	-	-	-	12.
Bone soup,	1,658.	141.	23.	-	25.	-	-	-	-	-	-	-	-
Dried soup from meat and bone,	296.	168.	199.	-	11.	-	-	-	-	-	-	-	13.
Dried soup from rendering cattle feet,	216.	150.	289.	-	9.	-	-	-	-	-	-	-	5.
Dried soup from horse rendering,	1,843.	-	22.	-	3.	-	-	-	-	-	-	-	-
Soap grease refuse,	585.	1,028.	64.	-	264.	-	-	-	-	-	-	-	26.

Ground bones,	135.	1,061.	77.	-	449.	-	-	-	-	-	-	-	22.
Meat and bone,	105.	-	91.	-	404.	-	-	-	-	-	-	-	24.
Tankage,	164.	-	123.	-	257.	-	-	-	-	-	-	-	-
Fish with less than twenty per cent. water,	244.	430.	152.	-	170.	-	-	-	-	-	-	-	40.
Fish with between twenty and forty per cent. water,	604.	412.	119.	-	142.	-	-	-	-	-	-	-	34.
Fish with more than forty per cent. water,	909.	310.	99.	-	102.	-	-	-	-	-	-	-	27.
Whale meat, raw,	890.	21.	96.	-	-	-	-	-	-	-	-	-	-
Lobster shells,	145.	-	90.	-	70.	-	445.	26.	-	-	-	-	5.
Castor-bean pomace,	194.	114.	110.	31.	44.	-	17.	6.	-	-	-	-	35.
Cotton-seed meal,	141.	116.	132.	35.	36.	-	-	-	-	-	-	-	6.
Linseed meal,	169.	-	127.	25.	37.	-	-	-	-	-	-	-	-
Rotten brewers' grain,	1,575.	-	15.	1.	17.	-	5.	3.	-	-	-	-	12.
Mill sweepings,	190.	-	75.	13.	24.	-	-	-	-	-	-	-	100.
Tobacco leaf,	261.	420.	55.	145.	9.	-	83.	43.	6.	-	-	-	83.
Tobacco stems,	212.	281.	46.	141.	12.	7.	78.	25.	-	-	-	-	16.
Cotton waste, wet,	694.	-	26.	16.	31.	-	49.	23.	-	-	-	-	827.
Cotton waste, dry,	117.	1,212.	35.	28.	9.	-	-	-	-	-	-	-	652.
Refuse from calico works,	81.	-	86.	-	239.	-	-	-	-	-	-	-	-
Cotton dust,	654.	1,019.	16.	9.	6.	-	-	-	-	-	-	-	844.
Glucose refuse,	162.	-	52.	3.	6.	-	4.	4.	-	-	-	-	1.
Waste from lactate factory,	682.	-	14.	-	13.	-	452.	-	-	-	-	-	138.
Hop refuse,	180.	-	20.	2.	4.	-	5.	2.	-	-	-	-	13.

Average Per Cents. of Different Ingredients found in the Preceding Compilation of Analyses, calculated to Pounds per Ton of 2,000 Pounds — Concluded.

	Moisture.	Ash.	Nitrogen.	Potash.	Total Phosphoric Acid	Soda.	Lime.	Magnesia.	Ferric and Aluminic Oxides.	Sulphuric Acid.	Carbonic Acid.	Chlorine.	Insoluble Matter.
III. Refuse Substances — Concluded.													
Banana skins,	280.	-	5.	109.	36.	-	-	-	-	-	-	-	-
Tankage and blood,	289.	-	118.	-	137.	-	-	-	-	-	-	-	-
Sumac waste,	1,261.	136.	24.	65.	-	-	23.	65.	-	-	-	-	45.
Eel grass,	708.	312.	17.	18.	6.	33.	43.	2.	-	-	-	-	21.
Pine-barren grass,	170.	48.	3.	1.	4.	-	-	-	-	-	-	-	33.
Pine needles,	200.	68.	9.	1.	2.	-	-	-	-	-	-	-	24.
Rockweed, green,	1,370.	474.	12.	-	-	-	-	-	-	-	-	-	-
Rockweed, dry,	214.	715.	29.	98.	55.	158.	153.	4.	-	-	-	-	208.
Jute waste,	262.	-	3.	2.	14.	-	-	-	-	-	-	-	-
Hair waste,	1,456.	-	28.	6.	12.	-	-	-	-	-	-	-	-
Starch waste from rubber factory,	200.	5.	4.	-	-	-	-	-	-	-	-	-	-
Sludge from sewage precipitating tanks,	1,770.	190.	1.	1.	2.	-	32.	8.	124.	-	-	-	19.
Sludge,	126.	-	14.	-	27.	-	173.	-	354.	-	-	-	761.
Residue from water filter,	1,884.	-	2.	-	1.	-	-	-	-	-	-	-	-
Blue-green algæ (*Lyngbia majuscula*), dry,	325.	-	85.	16.	4.	71.	41.	24.	-	-	-	-	111.

Mussel mud, wet,	1,200.	546.	4.	123.	2.	14.	19.	3.	70.	-	-	-	-
Mussel mud, dry,	45.	1,440.	14.	-	7.	-	1,468.	165.	-	-	-	-	752.
Madder,	239.	-	18.	48.	7.	-	79.	10.	-	-	-	-	93.
Salt mud,	1,567.	824.	8.	7.	-	19.	18.	7.	83.	-	-	-	798.
Fresh-water mud,	807.	-	27.	4.	5.	-	25.	6.	36.	-	-	-	365.
Muck,	1,234.	275.	16.	-	3.	-	-	-	-	-	-	-	214.
Peat, wet,	1,227.	153.	17.	4.	2.	-	11.	14.	43.	-	-	-	43.
Peat, dry,	293.	345.	38.	1.	1.	-	-	-	-	-	-	-	203.
Turf,	386.	127.	39.	-	-	-	-	-	-	-	-	-	-
Soot,	86.	1,542.	8.	13.	23.	-	60.	24.	128.	-	-	-	1,321.
IV. Animal Excrement, etc.													
Barn-yard manure,	1,345.	-	10.	11.	8.	-	6.	4.	-	-	-	-	160.
Horse manure,	225.	-	15.	56.	29.	-	-	-	-	-	-	-	252.
Sheep manure,	584.	-	29.	23.	18.	-	-	-	-	-	-	-	258.
Drainage from manure heap,	1,864.	73.	20.	18.	5.	-	-	-	-	-	-	-	-
Poudrette, dry,	105.	709.	72.	10.	115.	-	-	-	-	-	-	-	93.
Goose manure,	978.	-	4.	16.	19.	-	-	-	-	-	-	-	-
Hen manure, fresh,	1,047.	49.	20.	5.	15.	-	24.	18.	-	25.	-	-	470.
Hen-house refuse,	147.	-	14.	21.	20.	-	-	-	-	-	-	-	1,421.

5. Compilation of Analyses of Fruits, Garden Crops and Insecticides.

COMPILED BY H. D. HASKINS.

1. — Analyses of fruits.
2. — Analyses of garden crops.
3. — Relative proportions of phosphoric acid, potassium oxide and nitrogen in fruits and garden crops.
4. — Analyses of insecticides.

A computation of the results of a chemical analysis of twenty prominent garden crops shows the following average relative proportion of the three essential ingredients of plant food: —

	Parts.
Nitrogen,	2.2
Potassium oxide,	2.0
Phosphoric acid,	1.0

One thousand pounds of green garden vegetables contain, on the above-stated basis of relative proportion of essential constituents of plant food: —

	Pounds.
Nitrogen,	4.1
Potassium oxide,	3.9
Phosphoric acid,	1.9

The weight and particular stage of growth of the vegetables when harvested control, under otherwise corresponding conditions, the actual consumption of each of these articles of plant food. Our information regarding these points is still too fragmentary to enable a more detailed statement here beyond relative proportions. It must suffice for the present to call attention to the fact that a liberal manuring within reasonable limit pays, as a rule, better than a scanty one. — (C. A. Goessmann.)

1. Analyses of Fruits.

Fertilizing Constituents of Fruits.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Ericaceæ: —										
*Cranberries,	996	–	1.8	.9	.1	.3	.1	.3	–	–
*Cranberries,	894	.8	–	1.0	–	.2	.1	.3	–	–
Rosaceæ: —										
Apples,	831	.6	2.2	.8	.6	.1	.2	.3	.1	–
*Apples,	799	1.3	4.1	1.9	.3	.3	.3	.1	–	–
*Peaches,	884	–	3.4	2.5	–	.1	.2	.5	–	–
Pears,	831	.6	3.3	1.8	.3	.3	.2	.5	.2	–
Strawberries,	902	–	3.3	.7	.9	.5	–	.5	.1	.1
*Strawberries,	–	–	5.2	2.6	.2	.7	.4	1.0	–	–
*Strawberry vines,	–	–	33.4	3.5	4.5	12.2	1.3	4.8	–	–
Cherries,	825	–	3.9	2.0	.1	.3	.2	.6	.2	.1
Plums,	838	–	2.9	1.7	–	.3	.2	.4	.1	–
Saxifragaceæ: —										
*Currants, white,	–	–	5.9	3.1	.2	1.0	.3	1.1	–	–
*Currants, red,	871	–	4.1	1.9	.2	.8	.3	.9	–	–
Gooseberries,	903	–	3.3	1.3	.3	.4	.2	.7	–	–
Vitaceæ: —										
Grapes,	830	1.7	8.8	5.0	.1	1.0	.4	1.4	.5	.1
Grape seed,	110	19.0	22.7	6.9	.5	5.6	1.4	7.0	.8	.1

2. *Analyses of Garden Crops.*

Fertilizing Constituents of Garden Crops.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Chenopodiaceæ: —										
Mangolds,	880	1.8	9.1	4.8	1.5	.3	.4	.8	.3	.9
*Mangolds,	873	1.9	12.2	3.8	1.3	.6	.4	.9	–	–
Mangold leaves,	905	3.0	14.6	4.5	2.8	1.6	1.4	1.0	.8	2.3
Sugar beets,	805	1.6	7.1	3.8	.6	.4	.6	.9	.3	.3
*Sugar beets,	869	2.2	10.4	4.8	.8	.6	.4	1.0	.1	–
Sugar-beet tops,	840	2.0	9.6	2.8	2.3	.9	1.1	1.2	.2	.3
Sugar-beet leaves,	897	3.0	15.3	4.0	2.0	3.1	1.7	.7	.8	1.3
Sugar-beet seed,	146	–	45.3	11.1	4.2	10.2	7.3	7.5	2.0	1.9
*Red beets,	877	2.4	11.3	4.4	.9	.5	.3	.9	–	–
Spinach,	903	2.4	16.0	2.7	5.7	1.9	1.0	1.6	1.1	1.0
*Spinach,	922	3.4	9.6	9.6	2.1	.6	.5	.5	–	–
Compositeæ: —										
Lettuce, common,	940	–	8.1	3.7	.8	.5	.2	.7	.3	.4
Head lettuce,	943	2.2	10.3	3.9	.8	1.5	.6	1.0	.4	.8
*Head lettuce,	970	1.2	–	2.3	.2	.3	.1	.3	–	–
Roman lettuce,	925	2.0	9.8	2.5	3.5	1.2	.4	1.1	.4	.4
Artichoke,	811	–	10.1	2.4	.7	1.0	.4	3.9	.5	.2
*Artichoke, Jerusalem,	775	4.6	–	4.8	–	–	–	1.7	–	–
Convolvulaceæ: —										
Sweet potato,	758	2.4	7.4	3.7	.5	.7	.3	.8	.4	.9
Cruciferæ: —										
White turnips,	920	1.8	6.4	2.9	.6	.7	.2	.8	.7	.3
*White turnips,	895	1.8	10.1	3.9	.8	.9	.3	1.0	1.0	–
White turnip leaves,	898	3.0	11.9	2.8	1.1	3.9	.5	.9	1.1	1.2
*Ruta-bagas,	891	1.9	10.6	4.9	.7	.9	.3	1.2	–	–
Savoy cabbage,	871	5.3	14.0	3.9	1.4	3.0	.5	2.1	1.2	1.1
White cabbage,	900	3.0	9.6	4.3	.8	1.2	.4	1.1	1.3	.5
*White cabbage,	984	2.3	–	3.4	.3	.2	.1	.2	–	–
Cabbage leaves,	890	2.4	15.6	5.8	1.5	2.8	.6	1.4	2.4	1.3
Cauliflower,	904	4.0	8.0	3.6	.5	.5	.3	1.6	1.0	.3
Horse-radish,	767	4.3	19.7	7.7	.4	2.0	.4	2.0	4.9	.3

Fertilizing Constituents of Garden Crops — Continued.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Cruciferæ — Concluded.										
Radishes,	933	1.9	4.9	1.6	1.0	.7	.2	4.5	.3	.5
Kohlrabi,	850	4.8	12.3	4.3	.8	.4	.8	2.7	1.1	.6
Cucurbitaceæ: —										
Cucumbers,	956	1.6	5.8	2.4	.6	.4	.2	1.2	.4	.4
Pumpkins,	900	1.1	4.4	.9	.9	.3	.2	.7	.3	.4
Gramineæ: —										
Corn, whole plant, green,	829	1.9	10.4	3.7	.5	1.4	1.1	1.0	.3	.5
*Corn, whole plant, green,	786	4.1	–	3.8	.5	1.5	.9	1.5	–	–
Corn kernels,	144	16.0	12.4	3.7	.1	.3	1.9	5.7	.1	.2
*Corn kernels,	100	18.2	–	4.0	.3	.3	2.1	7.0	–	–
*Corn, whole ears,	90	14.1	–	4.7	.6	.2	1.8	5.7	–	–
*Corn stover,	282	11.2	37.4	13.2	7.9	5.2	2.6	3.0	–	–
Leguminosæ: —										
Hay of peas, cut green,	167	22.9	62.4	23.2	2.3	15.6	6.3	6.8	5.1	2.0
*Cow-pea (*Dolichos*), green,	788	2.9	–	3.1	.6	3.0	1.0	1.0	–	–
*Small pea (*Lathyrus sylvestris*), dry.	90	38.5	–	25.7	4.7	17.9	5.0	9.0	–	–
Peas (seed),	143	35.8	23.4	10.1	.2	1.1	1.9	8.4	.8	.4
Pea straw,	160	10.4	43.1	9.9	1.8	15.9	3.5	3.5	2.7	2.3
Garden beans (seed),	150	39.0	27.4	12.1	.4	1.5	2.1	9.7	1.1	.3
Bean straw,	166	–	40.2	12.8	3.2	11.1	2.5	3.9	1.7	3.1
Liliaceæ: —										
Asparagus,	933	3.2	5.0	1.2	.9	.6	.2	.9	.3	.3
Onions,	860	2.7	7.4	2.5	.2	1.6	.3	1.3	.4	.2
*Onions,	892	–	4.9	1.8	.1	.4	.2	.7	–	–
Solanaceæ: —										
Potatoes,	750	3.4	9.5	5.8	.3	.3	.5	1.6	.6	.3
*Potatoes,	798	2.1	9.9	2.9	.1	.1	.2	.7	–	–
Potato tops, nearly ripe,	770	4.9	19.7	4.3	.4	6.4	3.3	1.6	1.3	1.1
Potato tops, unripe,	825	6.3	16.5	4.4	.3	5.1	2.4	1.2	.8	.9
*Tomatoes,	940	1.7	–	3.6	–	.3	.2	.4	–	–
Tobacco leaves,	180	34.8	140.7	40.7	4.5	50.7	10.4	6.6	8.5	9.4
Tobacco stalks,	180	24.6	64.7	28.2	6.6	12.4	.5	9.2	2.2	2.4
*Tobacco stems,	106	22.9	140.7	64.6	3.4	38.9	12.3	6.0	–	–

Fertilizing Constituents of Garden Crops — Concluded.

[Average amounts in 1,000 parts of fresh or air-dry substance.]

	Moisture.	Nitrogen.	Ash.	Potassium Oxide.	Sodium Oxide.	Calcium Oxide.	Magnesium Oxide.	Phosphoric Acid.	Sulphuric Acid.	Chlorine.
Umbelliferæ: —										
Carrots,	850	2.2	8.2	3.0	1.7	.9	.4	1.1	.5	.4
*Carrots,	898	1.5	9.2	5.1	.6	.7	.2	.9	–	–
Carrot tops,	822	5.1	23.9	2.9	4.7	7.9	.8	1.0	1.8	2.4
Carrot tops, dry,	98	31.3	125.2	48.8	40.3	20.9	6.7	6.1	–	–
Parsnips,	793	5.4	10.0	.4	.2	1.1	.6	1.9	.5	.4
*Parsnips,	803	2.2	–	6.2	.1	.9	.5	1.9	–	–
Celery,	841	2.4	17.6	7.6	–	2.3	1.0	2.2	1.0	2.8

Most of the foregoing analyses were compiled from the tables of E. Wolff. Those marked * are from analyses made at the Massachusetts State Agricultural Experiment Station, Amherst, Mass.

3. *Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Fruits.*

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Ericaceæ: —			
*Cranberries,	1	3.0	–
*Cranberries,	1	3.4	2.6
Rosaceæ: —			
Apples,	1	2.7	2.0
*Apples,	1	1.9	1.3
*Peaches,	1	1.3	–
Pears,	1	3.6	1.2
Strawberries,	1	1.4	–
*Strawberries,	1	2.6	–
*Strawberry vines,	1	.7	–
Cherries,	1	3.3	–
Plums,	1	4.3	–
Saxifragaceæ: —			
*Currants, white,	1	2.8	–
*Currants, red,	1	2.1	–
Gooseberries,	1	1.9	–
Vitaceæ: —			
Grapes,	1	3.6	1.2
Grape seed,	1	1.0	2.7

Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Garden Crops.

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Chenopodiaceæ: —			
Mangolds,	1	6.0	2.3
*Mangolds,	1	4.2	2.1
Mangold leaves,	1	4.5	3.0
Sugar beets,	1	4.2	1.8
*Sugar beets,	1	4.8	2.2
Sugar-beet tops,	1	2.3	1.7
Sugar-beet leaves,	1	5.7	4.3
Sugar-beet seed,	1	1.5	–
*Red beets,	1	4.1	3.3
Spinach,	1	1.7	3.1
*Spinach,	1	19.2	6.8
Compositeæ: —			
Lettuce,	1	5.3	–
*Lettuce,	1	7.6	4.0
Head lettuce,	1	3.9	2.2
Roman lettuce,	1	2.3	1.8
*Jerusalem artichoke,	1	2.8	2.7
Convolvulaceæ: —			
Sweet potato,	1	4.6	3.0
Cruciferæ: —			
White turnips,	1	3.6	2.3
*White turnips,	1	3.9	1.8
White turnip leaves,	1	3.1	3.3
*Ruta-bagas,	1	4.1	1.6
Savoy cabbage,	1	1.9	2.5
White cabbage,	1	4.1	1.7
*White cabbage,	1	11.0	7.6
Cauliflower,	1	2.3	2.5
Horse-radish,	1	3.9	2.2
Radishes,	1	3.2	3.8
Kohlrabi,	1	1.6	1.8
Cucurbitaceæ: —			
Cucumbers,	1	2.0	1.3
Pumpkins,	1	.6	.7
Gramineæ: —			
Corn, whole plant, green,	1	3.7	1.9
*Corn, whole plant, green,	1	2.2	2.8
Corn kernels,	1	.6	2.8
*Corn kernels,	1	.6	2.6
*Corn, whole ears,	1	.8	2.5
*Corn stover,	1	4.4	3.7

Relative Proportions of Phosphoric Acid, Potassium Oxide and Nitrogen in Garden Crops — Concluded.

	Phosphoric Acid.	Potassium Oxide.	Nitrogen.
Leguminosæ: —			
Hay of peas, cut green, . .	1	3.4	3.4
*Cow-pea (*Dolichos*), . . .	1	3.1	2.9
*Small pea (*Lathyrus sylvestris*),	1	3.4	4.2
Peas (seed), ...	1	1.2	4.3
Pea straw, ...	1	2.8	4.0
Garden beans (seed), . . .	1.	1.2	4.0
Bean straw, ...	1	3.3	–
Liliaceæ: —			
Asparagus, ...	1	1.3	3.6
Onions, ...	1	1.9	2.1
*Onions, ...	1	2.6	–
Solanaceæ: —			
Potatoes, ...	1	3.6	2.1
*Potatoes, ...	1	4.1	3.0
Potato tops, nearly ripe, . .	1	2.7	3.1
Potato tops, unripe, ...	1	3.7	5.3
*Tomatoes, ...	1	8.7	4.5
Tobacco leaves, ...	1	6.2	5.3
Tobacco stalks, ...	1	3.1	2.7
Tobacco stems, ...	1	10.7	3.8
Umbelliferæ: —			
Carrots, ...	1	2.7	2.0
*Carrots, ...	1	5.7	1.7
Carrot tops, ...	1	2.9	5.1
*Carrot tops, dry, ...	1	8.0	5.1
Parsnips, ...	1	3.8	2.8
*Parsnips, ...	1	3.3	1.2
Celery, ...	1	3.5	1.1

6. *Analyses of Insecticides.*

	Moisture.	Arsenious Oxide.	Copper Oxide.	Acetic Acid.	Nicotine.	Mercury.	Sulphur.	Sulphuric Acid.	Chlorine.	Calcium Oxide.	Potassium Oxide.	Ferric and Aluminic Oxides.	Matter Insoluble in Hydrochloric Acid.
Average of 12 analyses, ordinary Paris Green,	1.22	57.91	32.08	4.74	-	-	-	-	-	-	-	-	.20
Average of 4 analyses, "Lion Brand New-process Paris Green,"	4.64	54.91	7.93	-	-	-	-	6.65	-	15.76	.35	-	1.00
"Sulphatine,"	1.40	-	2.61	-	-	-	48.28	4.73	-	18.60	-	-	1.63
"Death to Rose Bugs,"	2.95	-	1.05	-	-	-	34.53	4.35	-	17.76	-	-	.49
"Professor De Graff's Carpet Bug Destroyer,"	95.81	-	-	-	-	.78	-	.48	.27	-	.26	.90	-
"Oriental Fertilizer and Bug Destroyer,"	87.14	2.38	-	-	-	-	-	.64	3.00	-	3.50	-	-
"Non-poisonous Potato Bug Destroyer,"	-	-	-	-	-	-	-	-	-	68.20	-	1.38	1.50
Tobacco liquor,	37.71	-	-	-	2.12	-	-	-	-	3.07	6.55	.23	-
Tobacco liquor,	40.89	-	-	-	.53	-	-	-	-	1.47	16.34	.01	-
Tobacco liquor,	-	-	-	-	4.55	-	-	-	-	-	-	-	-
Tobacco liquor,	-	-	-	-	4.82	-	-	-	-	-	-	-	-
"Nicotinia,"	10.00	-	-	-	-	-	-	-	-	4.45	9.15	-	2.12
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	2.34
Hellebore,	-	-	-	-	-	-	-	-	-	-	-	-	38.12
"Peroxide of Silicate,"	1.65	.57	.33	-	-	-	-	49.66	-	41.18	-	-	2.31

As a rule, in all preceding analyses the essential constituents are determined and stated; blanks do not imply the absence of the non-essentials.

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